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TABLE OF CONTENTS

Page

FORMALIN FOR External Protozoan Parasites, by Frederic F. Fish 1
THE DEVELOPMENT of Anemia in Trout Fed a Synthetic Diet and its Cure by the Feeding of Fresh Beef Liver, by Arthur M. Phillips. 11
SALMON CULTURE in Japan, by Prof. M. Watanabe. 14
STERILIZING Hatchery Water Supplies, by William Hagen, Jr. 19
DO MUSKELLUNGE and Pickerel Interbreed? by Samuel Eddy 25
FROZEN FISH in Hatchery Diets may be Dangerous, by James S. Gutsell. 28
COMMENTS From our Readers:
Fish-Culture Doesn't End in the Hatchery, by J. Q. McGee 33
NOTES AND NEWS:
A Short Course for Fish Hatchery Foremen, by Matt L. Ryckman and Francis P. Griffiths. 34
Great Lakes Fishes Planted in South American Lake 36
Neon Lights Attract Insects to Trout Ponds 37
REVIEWS:
Haig-Brown: The Western Angler, an Account of Pacific Salmon and Trout, by P. R. Needham 38
Goodspeed: Angling in America, by Cecil Heacox 40
SUPPLEMENT:
Organization and Directory of Employees, U. S. Bureau of Fisheries. S1

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The PROGRESSIVE FISH-CULTURIST
News and Views from many Sources on Practical Hatchery Problems

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FORMALIN FOR EXTERNAL PROTOZOAN PARASITES

A REPORT ON THE PREVENTION AND CONTROL OF COSTIA NECATRIX

By Frederic F. Fish
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THE SMALLEST and most destructive of the ectoparasitic protozoans infecting salmon and trout, Costia necatrix, has unfortunately been relegated to virtual obscurity during the past few years. Few references to this parasite can be found in the recent literature and, where such things are discussed, one seldom hears a mention of Costia necatrix.

This apparent lack of interest in Costia certainly does not result from the infrequency of its appearances nor from any lack of pathogenicity on its part when it does occur. Preserved specimens of ailing trout and salmon submitted to the Seattle Pathology Laboratory for diagnosis have yielded very surprising indications concerning the frequency, intensity, and geographic distribution of Costiasis - surprising in that a parasite should be so widespread, so pathogenic, and yet so seldom mentioned. The answer undoubtedly lies in the fact that Costia, being small in size and usually sedentary in its habits, is being overlooked during parasitic examinations. Although Costia is not at all difficult to recognize, even well-trained workers unfamiliar with its appearance almost invariably pass it by.

The free-swimming forms of Costia are small, ovoid organisms bearing two or four flagella which usually cannot be seen except in stained preparations. The free-swimming form markedly resembles Octomitus and can be differentiated only through its characteristic movements and the fact that it is definitely flattened in cross section while Octomitus is round. The movements of the two parasites are distinctive - Costia swimming in a somewhat hesitating fashion as though uncertain as to its eventual destination whereas Octomitus seems quite confident as to where it is going and smoothly takes the shortest route to get there. Costia measures from 10 to 20 microns in length and from 5 to 10 microns in width - being but slightly smaller than Octomitus. Both parasites are often observed in the same preparation since in scraping the external epithelium from fish, intestinal contents are often unknowingly expressed onto the slide.

The free-swimming forms of Costia represent a minority of the population which may be present. For the most part, Costia seems quite content with a sedentary existence, remaining affixed to the epithelial cells of the host fish and apparently only adopting a vagrant existence when in search of a new location.

The favored place of attachment appears to be in the immediate vicinity of the dorsal fin or along the gill lamellae, literally hundreds of parasites - eight or ten affixed to a single epithelial cell - often being found in a single microscopic field. Costia can barely be detected under the standard low power of the microscope although under the high-dry objective it becomes very plain - assuming one recognizes the differences between Costia and the irregular cells often produced in the epithelial hyperplasia which accompanies infections of this parasite.

At one time, the pathogenicity of Costia necatrix was shadowed by considerable doubt. However, all doubt in this direction is removed from the mind of any investigator who may have an opportunity to observe this parasite actually at work. Such an opportunity arose during a series of prophylactic and therapeutic experimental treatments which were run at the Bureau's Birdsview (Washington) hatchery during the past summer.

EXPERIMENTS

The work at Birdsview was planned with no forethought of a specific infection by Costia necatrix. Considerable difficulty had been encountered in rearing blackspotted trout at this hatchery for several years and it was therefore decided to make a series of experimental treatments and observe their effect when, and if, a specific infection of any kind developed. For convenience, these experimental treatments were divided into two categories: prophylactic,or preventative, treatments which were routinely applied; and therapeutic, or curative, treatments, which were applied only after the disease had become established.

In accordance with this plan, a special shipment of 225,000 blackspotted trout eyed eggs, all of which had been taken by one spawntaker at the Pelican Creek racks in Yellowstone National Park on June 20, 1939, was sent to the Birdsview station. Immediately upon arrival on July 15, the eggs were tempered, placed in a large washtub, and thoroughly mixed to assure a uniform population. From this tub, eighteen lots of 2,112 eggs each (six ounces, the eggs running 352 per ounce) were measured out and incubated on single trays wedged in serially numbered upper troughs.

Hatching began almost immediately and was complete in all troughs on July 20. On July 26, prophylactic treatments were started and continued for the duration of the experiment.

The volume of water contained in a trough with a mean depth of four inches was established by multiplying the inside length by the inside width and multiplying the product obtained by the mean depth, all dimensions in inches. Multiplying the final product of these three figures by 16.4 gave the water content in cubic centimeters. The prophylactic treatments were administered by stopping the inflowing water and immediately adding sufficient disinfectant - predissolved in the case of the boric acid and the copper sulphate - to yield the particular disinfectant-concentration desired. At the end of the one-hour exposure, the trough was gently drained to remove the disinfectant and the water supply resumed. No aeration was attempted or required during the one hour period of treatment.

Table 1. Schedule of Prophylactic Treatments

Trough Number	Treatments
1 2 3 4 5 6 7 8	Reserved untreated for therapeutic measures.
9 10	Treated with boric acid, 1:500, one hour weekly.
11 12	Treated with copper sulphate, 1:500,000, one hour weekly.
13 14	Treated with formalin, 1:2,500, one hour weekly.
15 16	Treated with formalin, 1:6,000, one hour weekly.
17 18	Untreated controls.

Throughout the period of experimentation, a representative sample of the population in each trough was weighed and counted to determine the average weight per fish. Daily mortalities were recorded by actual count. The routine hatchery diet, part fresh and part dry feed, was fed although, unfortunately, with the limited assistance available for this work it was impossible to weigh the amount of food fed to the fish in each of the eighteen experimental troughs.

On September 13, a definite upward trend in the daily mortalities had become apparent for several days and the fish in some of the troughs were observed scratching themselves - definite indications of trouble present. A microscopic examination of the fish revealed no cause for trouble other than large numbers of Costia necatrix. The weekly prophylactic treatments were continued as before and therapeutic treatments were administered on that date to the fish in the previously untreated troughs, 1 to 8. Both microscopic examination and the daily losses indicated that the intensity of infection varied between different troughs and, as there is no quantitative method of assaying Costia infections, it was deemed advisable to treat alternate troughs with identical methods rather than a continuous series of troughs. Accordingly, troughs 1, 3, 5 and 7 were given a prolonged treatment for one hour with a 1:4,000 solution of formalin using exactly the same technique employed in the prophylactic treatments. Troughs 2, 4, 6 and 8 were given a direct three per cent salting - the orthodox method for treating Costia. Unfortunately, through a misunderstanding, troughs 17 and 18, which were supposedly untreated control troughs, were likewise salted at this time. No additional treatments were administered in the therapeutic treatment troughs until October 14 when troughs 1, 3, 5 and 7 were given a second treatment with the 1:4,000 formalin solution although there was no visible evidence that such treatment was indicated. Troughs 2 and 4 were given a second salting on that date and the fish in troughs 6 and 8 were given a two minute hand dip in a 1:2,000 solution of copper sulphate.

Table 2. Schedule for the Therapeutic Treatment Troughs

Trough Number	Treatment	Date
1	Formalin, 1:4,000, 1 hour	September 13
	" " "	October 14
2	Salt, 3%	September 13
	"	October 14
3	Formalin, 1:4,000, 1 hour	September 13
	" " "	October 14
4	Salt, 3%	September 13
	"	October 14
5	Formalin, 1:4,000, 1 hour	September 13
	" " "	October 14
6	Salt, 3%	September 13
	Copper sulphate, 1:2,000, 2 minutes	October 14
7	Formalin, 1:4,000, 1 hour	September 13
	" " "	October 14
8	Salt, 3%	September 13
	Copper sulphate, 1:2,000, 2 minutes	October 14
17-18	Salt, 3%	September 13

The experiment was terminated on November 7 when impending winter conditions in the mountainous areas in which these fish were to be liberated made their immediate release imperative.

The results of this experiment are best given in the form of a tabulation of the losses from the individual troughs and as averages of all troughs undergoing identical treatments. The average accumulative losses for both the therapeutic and the prophylactic treatments, as well as the average growth rates of the latter fish, are also given in graph form.

DISCUSSION OF RESULTS

Prophylactic treatments.- It is obvious that the boric acid treatments administered in this experiment were essentially valueless in preventing an epidemic of Costiasis as there is little difference between either the degree or time of the losses occuring in troughs 9 and 10 which were so treated and the losses in troughs 17 and 18 which, for all intents and purposes, may be considered as untreated controls.

Routine weekly treatments with copper sulphate, 1:500,000, proved definitely beneficial in preventing Costiasis as no evidence of infection appeared in troughs 11 and 12 which received this type of treatment. However, it is significant that the copper sulphate treatments, although preventing Costiasis, did materially impede the growth of the fish. This no doubt resulted from the well known fact that fish usually are disinterested in food for some time subsequent to treatment with copper sulphate.

Table 3. THE PREVENTION AND CONTROL OF COSTIA NECATRIX

Losses by five-day periods

Trough Number	7/15 to 7/19	7/20 to 7/24	7/25 to 7/29	7/30 to 8/3	8/4 to 8/8	8/9 to 8/13	8/14 to 8/18	8/19 to 8/23	8/24 to 8/28	8/29 to 9/2	9/3 to 9/7	9/8 to 9/12	9/13 to 9/17	9/18 to 9/22	9/23 to 9/27	9/28 to 10/2	10/3 to 10/7	10/8 to 10/12	10/13 to 10/17	10/18 to 10/22	10/23 to 10/27	10/28 to 11/1	11/2 to 11/6	Total Loss
Treated with formalin, 1:4,000, one hour, September 13 and October 14																								
1	2	28	40	52	81	26	22	11	5	5	5	15	20	10	4	1	7	4	2	2	1	2	1	346
3	1	24	26	26	85	52	27	17	8	2	3	8	6	8	2	1	3	5	7	1	0	0	3	316
5	2	20	16	23	32	19	13	16	7	10	16	18	36	10	54	1	8	5	9	8	3	3	3	331
7	2	23	34	44	56	16	9	6	8	6	19	50	47	11	40	4	3	7	1	2	2	0	4	394
Av.	2	28	29	36	64	28	18	13	7	6	11	23	27	10	25	2	5	5	5	3	2	1	3	347
Treated with 3% salt, September 13 and October 14																								
2	2	21	16	73	84	85	15	14	8	3	4	9	17	22	104	70	79	50	39	21	10	17	10	773
4	2	25	21	36	81	61	29	22	11	5	5	42	53	51	154	44	82	30	15	9	2	2	1	783
Av.	2	23	19	55	83	73	22	18	10	4	5	26	35	37	129	57	80	40	27	15	6	10	6	778
Treated with 3% salt, September 13 and Copper sulphate, 1:2,000, two minutes, October 14																								
6	3	34	23	17	47	17	34	20	10	2	13	14	36	29	74	39	102	74	68	17	22	3	7	705
8	3	25	16	16	38	19	15	19	10	6	11	42	66	66	147	88	74	32	29	7	8	3	3	743
Av.	3	30	20	17	43	18	25	20	10	4	12	28	51	48	111	64	88	53	49	12	15	3	5	724
Treated with boric acid, 1:500, one hour weekly																								
9	1	26	11	29	32	17	15	14	7	5	7	16	22	66	101	87	112	38	49	44	13	7	5	724
10	1	23	24	54	52	14	19	30	10	8	15	16	37	50	49	65	76	46	29	20	6	4	4	652
Av.	1	25	18	42	42	16	17	22	9	7	11	16	30	58	75	76	94	42	39	32	10	6	5	688
Treated with Copper sulphate, 1:500,000, one hour weekly																								
11	3	19	24	48	53	16	11	22	11	7	9	6	14	12	13	3	1	3	4	46	28	5	5	363
12	1	23	21	41	27	10	14	19	13	20	14	9	11	16	6	2	0	4	4	3	0	0	1	259
Av.	2	21	23	45	40	13	13	21	12	14	12	8	13	14	10	3	1	4	4	25	14	3	3	311
Treated with formalin, 1:2,500, one hour weekly																								
13	2	19	173	84	28	18	12	7	4	2	2	1	2	1	5	0	1	1	0	0	0	2	1	365
14	1	31	117	122	25	36	19	12	2	2	4	2	4	7	3	1	1	1	1	1	0	1	1	394
Av.	2	25	145	103	27	27	16	10	3	2	3	2	3	4	4	1	1	1	1	1	0	2	1	380
Treated with formalin, 1:6,000, one hour weekly																								
15	1	19	84	56	17	13	10	8	2	2	1	1	3	1	0	0	2	0	0	0	0	0	0	220
16	2	28	65	47	16	18	9	6	10	0	4	3	3	3	1	0	0	0	0	2	2	2	2	223
Av.	2	24	75	52	17	16	10	7	6	1	3	2	3	2	1	0	1	0	0	1	1	1	1	222
Untreated controls																								
17	3	16	11	33	16	14	12	21	4	7	6	6	15	30	78	64	108	62	83	63	29	10	10	701
18	0	27	17	29	34	23	9	18	4	5	6	8	15	21	85	37	90	55	60	47	14	3	11	618
Av.	2	22	14	31	25	19	11	20	4	6	6	7	15	26	82	51	99	59	72	55	22	7	11	660
Mean Water Temperature	52	56	59	57	57	58	57	57	56	54	54	54	52	54	53	51	49	50	50	50	50	46	47	

Formalin, 1:2,500, in one-hour weekly exposures definitely prevented Costiasis and, furthermore, fish so treated exhibited the greatest growth of any groups in the prophylactic series. It will be noted on the graph of accumulative losses for the prophylactic treatments that this concentration of formalin produced definite toxic effects immediately following the first three applications but not thereafter. As a 1:2,500 concentration of formalin has been demonstrated experimentally to be non-toxic to #2 fingerlings, two possible explanations for the evident toxicity in this experiment occur. In the first place, this concentration of formalin may be toxic to sac-fry and not to larger fish. Secondly, and from subsequent experiments this explanation seems more likely, this toxicity may well have resulted from the mode of application. In applying the formalin treatments, the requisite amount of formalin merely was added to the water in the trough. It is now believed that under such conditions, a homogeneous solution is not reached with sufficient celerity. The toxicity was apparent only when the experimental fish were in the sac-fry stage when, presumably, they were unable to swim away from any areas of hyperconcentration which may have been produced. As soon as the sac had been absorbed and the fish were actively swimming, as is indicated on the graph by the point at which the first food was given, this concentration of formalin produced no ill effects.

The same conclusions seem warranted for the weekly treatments in formalin at a 1:6,000 concentration. The total losses on troughs 15 and 16, routinely treated with the 1:6,000 concentration, were definitely lower than those in any other group in spite of the relatively large number of fish killed by the initial two treatments. As an indication of the efficacy of this disinfectant, it may be noted that during the entire 71-day period between August 27 and November 7, the combined losses in troughs 15 and 16 were only 32 fish out of 3,813 present on August 27. This represents a loss of less than one per cent during a ten-week period in which an epidemic of Costiasis raged throughout the entire hatchery and yet no special effort was made to avoid spreading the infection to these troughs. As a comparison, the combined losses in the untreated control troughs 17 and 18 during the same 71-day period were 1,039 fish, or approximately 26 per cent of the fish present on August 27.

Therapeutic treatments.- Essentially, the therapeutic treatments consisted of a comparison between the relative efficacy of a one-hour treatment with formalin, 1:4,000 and that of salting - the usual treatment for Costiasis. Both these methods of treatment were applied to four individual troughs on September 13 when the presence of Costia necatrix was first detected.

The formalin treatment definitely removed all traces of infection. A prolonged microscopic search for Costia, made on fish taken from each of troughs 1, 3,5 and 7 immediately after the treatment was concluded, failed to reveal a single parasite. The complete eradication of Costia by a single treatment with a 1:4,000 solution of formalin is further indicated by the fact that during the 55-day period between the date of treatment and the termination of the experiment, the combined losses in these four troughs totaled 313 fish out of 7,374 present in the four troughs when treatment was administered.

The salting, on the other hand, failed to produce more than a two-day arrest of the course of the infection. In the same 55-day period between the time of the treatment and the end of the experiment, the salted troughs 2, 4, 6 and 8 yielded a loss of 1,791 fish out of the 7,282 present on September 13. The losses in these troughs continued at such a high level that a second treatment was attempted on October 14. As the previous salting had failed to produce but a momentary check on the losses, it was decided to hand dip the fish of troughs 6 and 8 in a 1:2,000 solution of copper sulphate for two minutes and compare the efficacy of this treatment with that of the second salting. As may be seen from the graph of "Therapeutic Treatments," the epidemic of Costiasis had about run its normal course by October 14 and both methods of treatment were equally effective

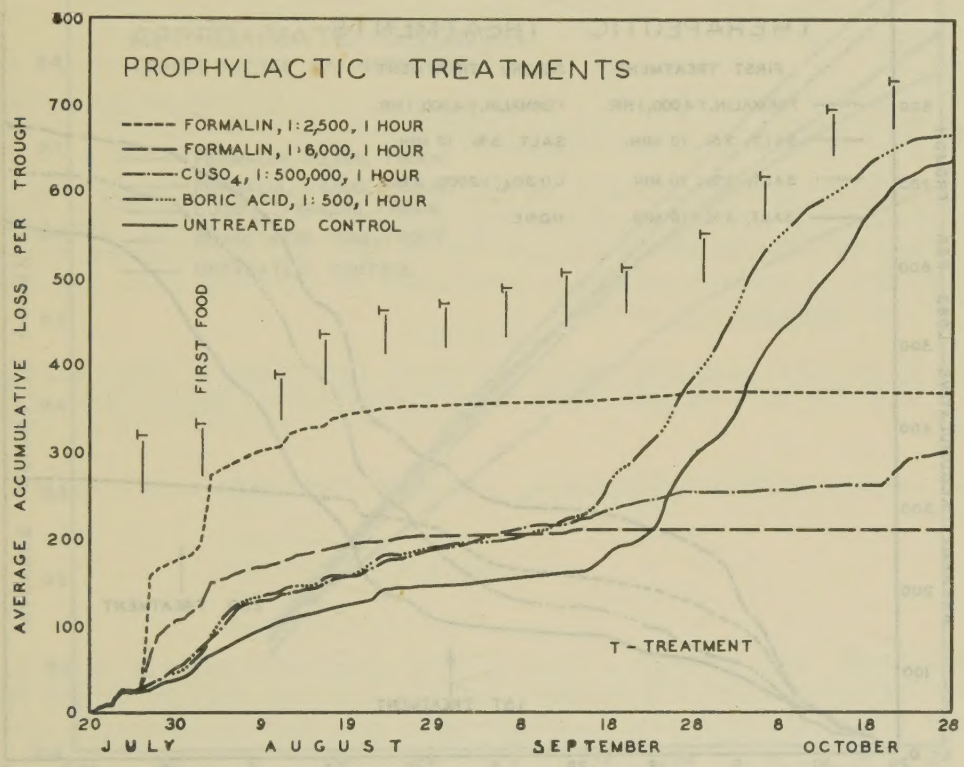

Figure 1.

in terminating what infection remained. Whether hand dipping in copper sulphate might have proven more effective than salting had it been applied in the early stages of the infection is conjectural.

CONCLUSIONS

It is concluded from this experiment that a carefully administered routine treatment of one hour in a 1:6,000 solution of formalin at weekly intervals will effectively prevent infections of Costia necatrix. From previous experiments,

it is believed that this treatment would likewise prevent outbreaks of Trichodina (Cyclochaeta). Plehn and Kingsbury and Embody have recommended formalin as an effective cure for Gyrodactylus. Hence, it is probably true that treatments with formalin, 1:6,000, would completely remove all threats from any of the external parasites of trout and salmon.

Several words of caution concerning the application of prolonged treatments with formalin seem in order. Prolonged treatments of any kind still are in the experimental stage and, as yet, are not to be recommended for treating large ponds containing many fish. Formalin is not highly toxic to fish life. Healthy fish

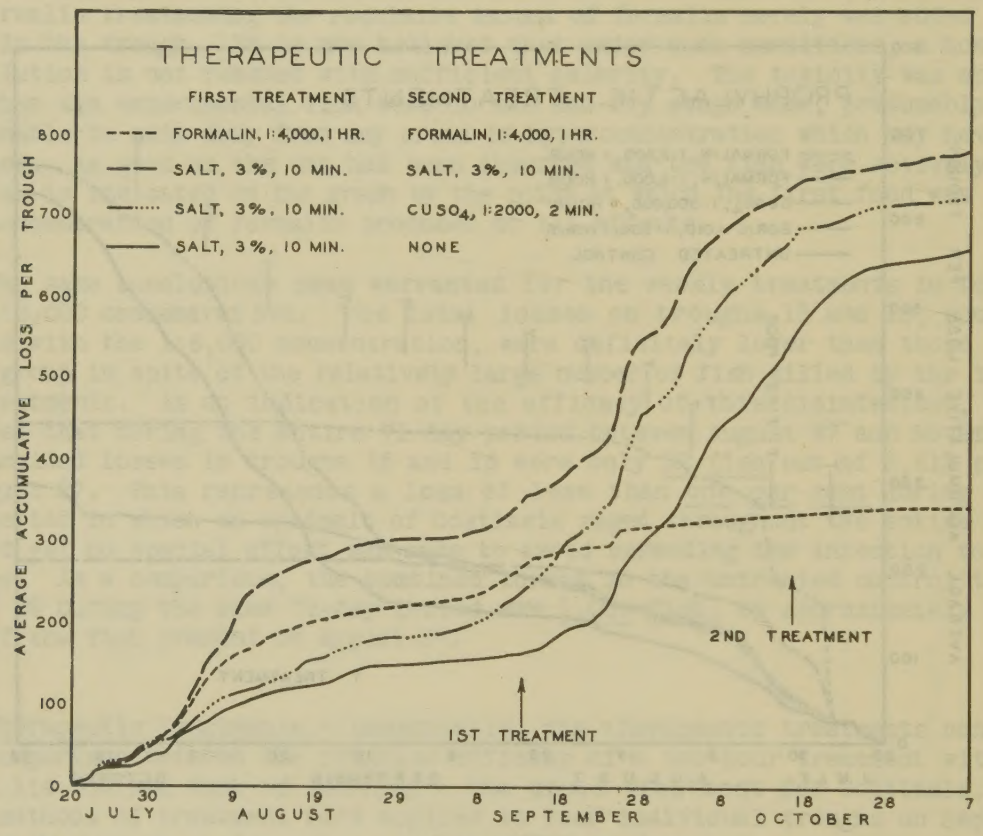

Figure 2.

will tolerate repeated exposures to a 1:4,000 concentration of formalin for two hours with no ill effects. However, the problem of obtaining the desired concentration in a pond or trough by the use of full-strength formalin is not an easy one to solve. If the full-strength formalin is added directly to the pond, localized areas of hyperconcentration exist until the reagent has been thoroughly mixed with the water, an accomplishment usually requiring some minutes. It is preferable to dilute the formalin used in a treatment to the maximum which can be handled conveniently before adding it to the pond or trough to be treated and thus materially reducing the strength of solution present in any areas of hyperconcentration. In so doing, however, one must compensate for the amount of water

used in making such dilution. A sprinkling can, or similar container, proves very useful in uniformly distributing the disinfecting solution to all parts of the pond. It is obviously better to distribute the diluted formalin uniformly, even though it may require several minutes to do so, rather than adhere to the one-hour contact with the disinfectant. Even a 100% increase in the one-hour exposure time will not adversely affect the fish but a relatively slight increase in the disinfectant-concentration much in excess of 1:2,500, even locally, might.

A second danger involved in applying prolonged treatments of any kind lies in asphyxiation, although this is not as great as is usually assumed. In ponds,

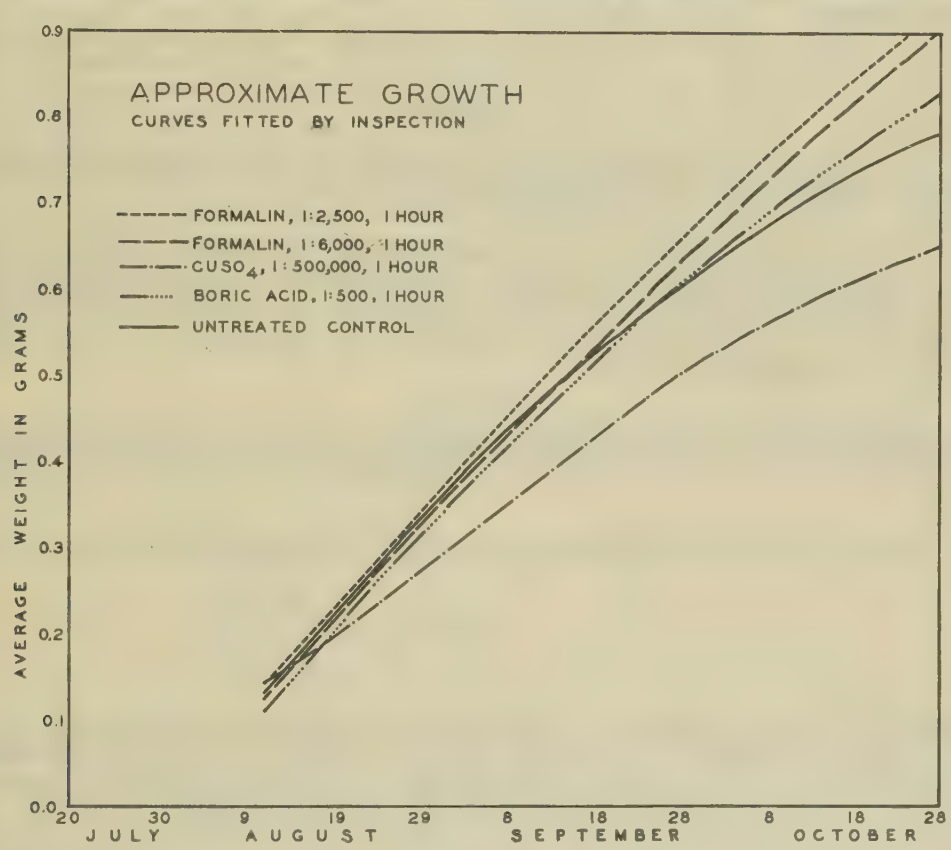

Figure 3.

some form of aeration by recirculation can be advantageously used. This precaution is seldom necessary in troughs unless very large numbers of fish are being carried. It has been reported that as many as 6,000 #1 1/2 fingerlings, or approximately 134 fish per gallon of water, have been safely treated with formalin for one hour in a standard trough containing 43.4 gallons of water with no more aeration than ordinarily would be given to fish cans. Experiments are now under way at the Seattle Pathology Laboratory to determine how many fish can safely be treated without aeration under various conditions. However, until more definite data are available on this subject, it is wise to play safe.

It is concluded from the therapeutic treatments administered in this experiment that a one-hour treatment with a 1:4,000 concentration of formalin is the most effective, the most practical, and the most economical treatment for eradicating the external protozoan parasites of hatchery trout and salmon.

From the highly beneficial results following a single application of formalin at a 1:4,000 concentration, it is assumed that routine treatments need not be applied oftener than once every two weeks or possibly once a month. Considering the effort and fish sacrificed combating parasitic infections after they have gained a foothold, a simple bi-weekly or monthly treatment with formalin is cheap insurance indeed.

SUMMARY

1. A series of experiments with prophylactic and therapeutic treatments spanning an epidemic of Costia necatrix is described.

2. From these experiments it is concluded that routine bi-weekly or possibly monthly treatments consisting of one-hour exposures to a 1:6,000 concentration of formalin may be recommended as a simple, effective, and cheap method for preventing infections of the ectoparasitic protozoans on hatchery fish, and presumably infections of Gyrodactylus as well.

3. It is also concluded that established infections of these ectoparasites can be eradicated by a single one-hour exposure to a 1:4,000 concentration of formalin.

4. Certain hazards accompanying prolonged treatments with formalin are discussed.

CHARLESTON, WEST VIRGINIA.- Trout feeding experiments carried on by Dr. J. A. Gutsell, Assistant Aquatic Biologist, at the Leetown station of the Bureau of Fisheries during the past year, indicate that in a well-balanced diet as much as 50 per cent of dry meals can be used with satisfactory results.

The addition of either 3 per cent of cod-liver oil or of the same amount of kelp meal material increased the rate of growth, while trout on a diet containing both of these products grow considerably faster than when only one is used. Although overfeeding brood fish reduced the hatchability of the eggs, underfeeding had no bad effect and eggs from these fish were produced at less cost than from fish that were fed a normal amount.

MARION, ALABAMA.- Approximately 1/4 million fingerling bass and bream left when 7 ponds were drained at the local hatchery have been distributed to suitable streams throughout the State.

MEATLESS DIETS AND ANEMIA

THE DEVELOPMENT OF ANEMIA IN TROUT FED A SYNTHETIC DIET AND ITS CURE BY THE FEEDING OF FRESH BEEF LIVER

By Arthur M. Phillips, Jr.
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McCAY AND DILLEY (1927) found that trout fed a synthetic diet for long periods eventually began dying in great numbers. This mortality could be stopped or prevented by the feeding of fresh meat. All attempts to date to isolate the factor preventing the mortality have been failures. In 1938 Wales and Moore published an observation of an extremely low blood count which occurred in trout after prolonged feeding of a commercial dog food containing no fresh meat. The present paper deals with a series of blood counts conducted on brook trout fingerlings fed a synthetic diet until mortality became quite marked, at which time their diet was supplemented with fresh beef liver. The blood counts were continued until they were as high as those obtained at the beginning of the experiment.

PROCEDURE

Brook trout fingerlings averaging 6.6 grams were placed on a synthetic diet consisting of the following ingredients.

Raw corn starch	34 per cent
Dextrin	34 " "
Casein	20 " "
Mineral mixture 1/	4 " "
Yeast	5 " "
Cod liver oil	3 " "

The fish were held in 47° F water throughout the course of the experiment.

It was found to be extremely difficult to obtain blood counts with the standard pipette for red cells from fish as small as those used in this experiment. The Will Corporation of Rochester, New York, very kindly manufactured a "micro" red cell pipette which required approximately one-tenth as much blood as the usual pipette, yet gave the same end dilution of 1:200. A satisfactory blood sample was obtained from the fish by pinning the trout on its back to a board by means of a pin inserted through the lower and upper jaw. A pair of small scissors was then used to snip through the body wall into the heart. The fish was allowed to "bleed" for a few seconds and then the necessary blood sample taken. The standard diluting solution was found to be satisfactory for fish blood. Duplicate counts were made on each of six fish at intervals of one or, in some cases, two weeks.

1/ Mineral mixture consisted of equal parts of bone meal, sodium chloride and calcium carbonate, with 7.5 parts by weight of potassium iodide added for every kilogram of the mineral mixture.

DISCUSSION

Each set of counts was averaged and these values are plotted in Figure 1. The blood count dropped quite rapidly the first week the fish were fed the synthetic diet. From this point on the drop was consistent but less rapid. The first mortality was noticed the sixth week, at which time the count was 710,000 red cells per cubic millimeter. The mortality increased rapidly until at the end of the ninth week it was so great that the fish were given fresh beef liver to the extent of fifty per cent of their diet in order that sufficient trout might be available to complete the observations. The blood count at this time was 557,000 cells per cubic millimeter.

After the addition of beef liver, the mortality decreased gradually until it had stopped by the eleventh week, at which time the blood count was 700,000 cells per cubic millimeter. It is interesting to note that the mortality began and stopped at essentially the same red cell count. The red cell content of the blood continued to increase until at the end of the 20th week it had reached the values obtained at the beginning of the experiment.

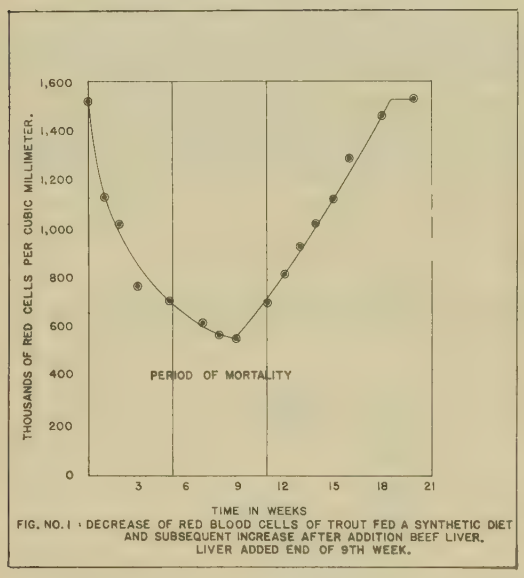

FIG. NO. 1 - DECREASE OF RED BLOOD CELLS OF TROUT FED A SYNTHETIC DIET AND SUBSEQUENT INCREASE AFTER ADDITION BEEF LIVER. LIVER ADDED END OF 9TH WEEK.

Figure 1.

The red cell count dropped at a rapid rate at first and this rate decreased gradually until the fish were fed fresh liver. The rise in cell content of the blood took place at a more uniform rate. This is clearly shown in the graph.

It would seem desirable to use the development of anemia as an index of Factor H deficiency of trout. In the past mortality has been used as an indication that the fish were suffering from the lack of this essential constituent of the diet. When the supplement being tested was added to the diet, the fish themselves were in an extremely unhealthy condition. If, however, the blood count were taken as an indication of deficiency, this more sensitive test would make it possible to add the supplements before excessive mortality began. These experiments shed a possible light upon the effect of Factor H upon the health of trout. Anemia develops quite rapidly in its absence and is very marked, the trout losing in these experiments about one-third of the red cell content of the blood.

It might be interesting to determine red cell counts of fish during outbreaks of some of our common hatchery diseases. Should there be a correlation between the appearance of some of these diseases and the numbers of either white or red blood cells, it would provide a relatively easy and rapid method for the diagnostician.

SUMMARY

1. Fish fed a synthetic diet showed a rapid decrease in the number of red blood cells per cubic millimeter the first week, followed by a consistent but more gradual reduction.

2. Mortality first appeared when the count fell to 710,000 cells per cubic millimeter and increased rapidly as the count dropped still farther.

3. The addition of fresh beef liver caused a decrease in the mortality and at the same time an increase in the red cell content of the blood. Mortality stopped when the count reached 700,000.

4. The rise in red cells after the addition of beef liver was observed to take place at a more uniform rate than did the decrease on synthetic diet.

5. It is suggested that the red cell count be used as an index in tests for Factor H deficiency of trout, thus giving a better and earlier indication than appearance of mortality that fish are suffering from the lack of this food essential.

6. The appearance of a rapid and marked anemia shed some additional light as to the effect of the lack of Factor H upon the health of brook trout.

7. It is suggested that a study of the red cell count of the blood of trout suffering from some of the common hatchery diseases might be interesting and helpful.

The above work was carried out at the Cortland Experimental Hatchery which is under the joint operation of the Bureau of Fisheries, the New York State Conservation Department and Cornell University.

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SALMON CULTURE IN JAPAN

THE CHITOSE SALMON HATCHERY

By Prof. M. Watanabe
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FOR THE ARTIFICIAL propagation of salmon and trout Japan is much indebted to the United States. For instance, the method of artificially hatching salmon was introduced to Japan from the United States in 1876 by the late Mr. M. Sekizawa, who had acquired the technique there. The rainbow trout and brook trout which are widely propagated in Japan now were transplanted from America. Moreover, the Chitose Salmon Hatchery, which I am going to introduce here to American readers, was established in 1888 in imitation of the Bucksport Salmon Hatchery in Maine. The Chitose Hatchery was established by the late Mr. I. Ito, an expert of the Hokkaido Government, who had inspected the fisheries of the United States.

The Chitose Salmon Hatchery, the largest in Japan, belongs to the Hokkaido Government and is situated on the Chitose River. This river is a tributary of the Ishikari River, which is the longest in Japan and is famous for its salmon. The hatchery celebrated the fiftieth anniversary of its founding last year. During these fifty years the Chitose Hatchery has developed greatly and has rendered very considerable services to the artificial propagation of salmon in Japan.

There are 347 salmon and trout hatcheries in Japan, of which 130 are for the anadromous species. Since Hokkaido leads all the other provinces in the production of salmon it is natural that the hatcheries should be concentrated here. There are 51 salmon hatcheries in Hokkaido, or about 40 per cent of the total number in Japan. The approximate number of eggs which are taken by the hatchery in Hokkaido every year are as follows: Dog salmon eggs, over 300 millions; pink salmon eggs, scores of millions.

The photograph above shows one of the five hatching houses at the Chitose Salmon Hatchery.

Figure 2. The Chitose Salmon Hatchery. Rearing ponds for salmon appear in right foreground, trout culture ponds in background at left, with one of the hatching houses. Group of buildings in right background includes an office, laboratory and several hatching houses.

In Japan the dog salmon (Oncorhynchus keta) is most common, but in Hokkaido we have some pink salmon (Oncorhynchus gorbuscha) also.

The Chitose salmon hatchery has an area of 81 acres, where we have much good spring water. The temperature of the water is 8° C. (46.4° F.) all the year round. There are five hatching houses in which the Atkins hatching troughs are arranged. There have been no important modifications in this trough since it was imported to Japan by Mr. Ito. We have ten rearing ponds for salmon fry and another ten for trout culture. The hatchery has a capacity of over 53 million eggs at one time, and from 20 to 60 million eggs are handled, on the average, every season. In 1934, when we had a very big run of salmon in the Chitose River, 101 millions of dog salmon eggs were taken, all of which were cared for in this hatchery. I think this is a record for the largest number of salmon eggs to be handled in any hatchery in the world in one season.

The salmon migrate in the Chitose River from the end of September to the middle of the following February, with the heaviest run from the middle of December to the beginning of January. The egg-taking station is located about 4 miles down the river from the hatchery. Here a salmon-catching wheel of American style is operated very successfully, turning round on the clear Chitose River every

year during the salmon season. The wheel is set up in the river in September, and salmon are taken in it from the beginning of October to the end of the following January or the first of February.

As the egg-taking station is situated just below the natural spawning place of the salmon almost all of the fish are matured before they arrive there, so it is unnecessary to hold them for any period of time before taking the eggs. The eggs are taken by cutting the belly of the fish and are fertilized by the dry method. The percentage of fertilization is very good - almost 100 per cent.

From the egg-taking station the eggs are transported to the Chitose Hatchery, where they are placed in the Atkins hatching troughs. Sixty-one to sixty-two days are required for the eggs to hatch.

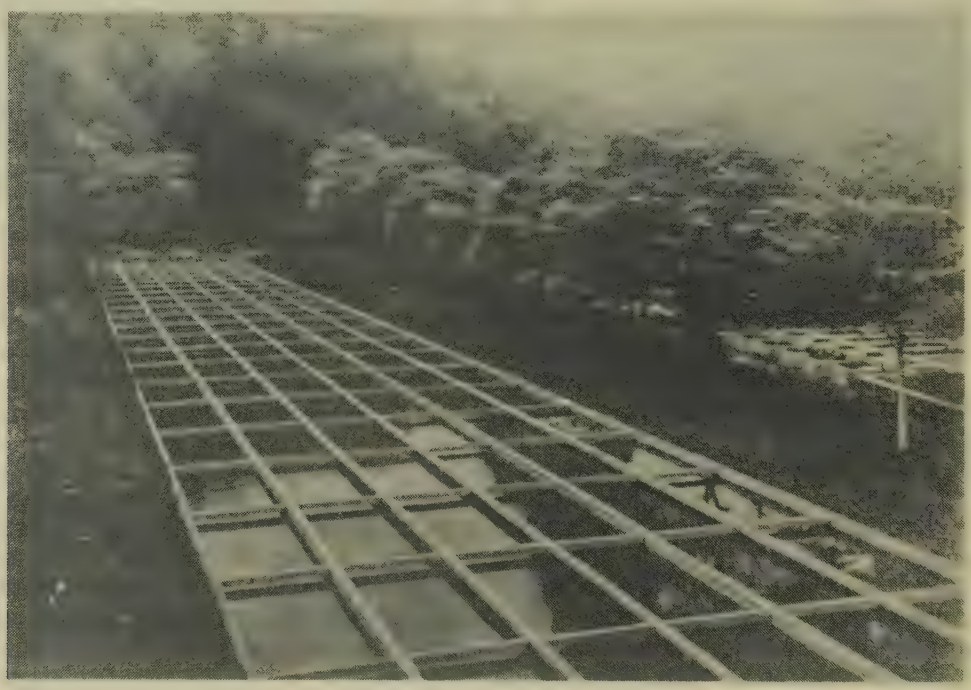

Figure 3. Rearing ponds for salmon fry.

During the course of incubation we must contend with the usual diseases. The development of the water molds on the egg is most troublesome, as it is in the hatcheries of America. The dead eggs are removed from the trays as many times as possible after the eyed stage. Once we had a very heavy mortality of the eggs due to a soft egg disease caused by bacteria at a hatchery in Hokkaido. It was found that soaking the eggs in 0.5 per cent formalin about thirty minutes once a week is very effective in combatting this disease. This treatment also prevents the development of fungus on the eggs, so that if this method is applied it is not necessary to remove the dead eggs at all until the end of incubation.

After the fry hatch they are removed from the troughs and placed in the rearing ponds, which are covered with boards to protect the fry from the direct sun light. About 38 years ago there was a very heavy mortality of fry at the yolk-sac stage in the rearing ponds. After investigation and experiment it was found that the direct sunlight is harmful to the fry, so the rearing ponds are covered with boards now. After the yolk is absorbed and the fry swim up freely, the covering boards are removed.

It requires a very extensive area of ponds and enormous quantities of food to feed the scores of millions of fry until they grow up to a length of 7 cm. (2 3/4 inches) or so. Therefore the fry are generally liberated in the river from the rearing pond when they have totally absorbed the yolk. When the river

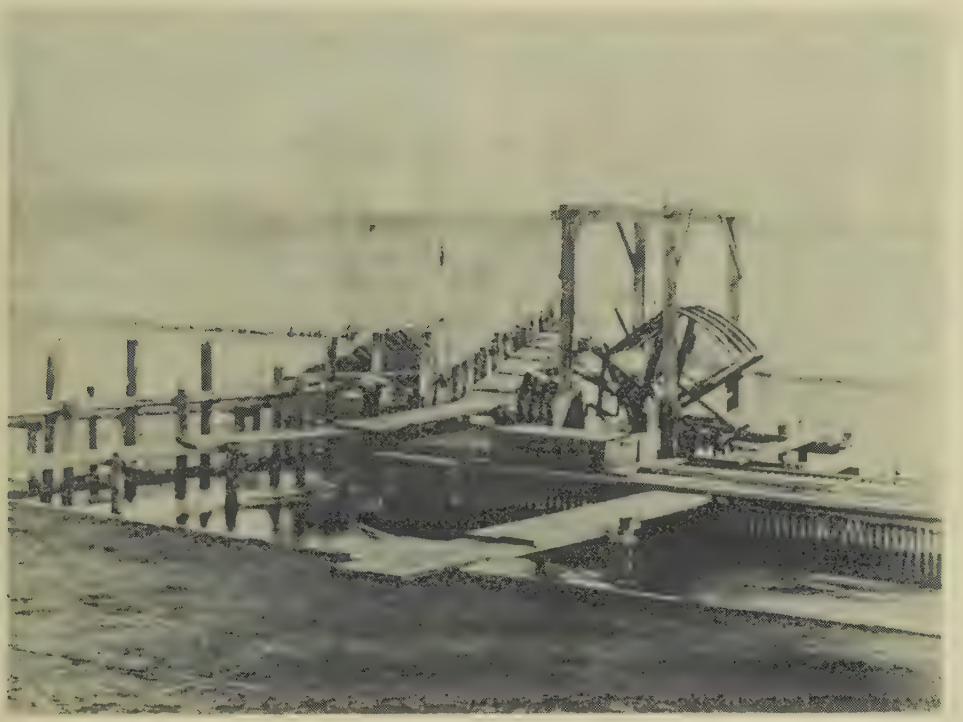

Figure 4. Salmon wheel on the Chitose River.

is flooded with the water of melting snow or heavy rain, however, they are cared for and not liberated until later. When it is necessary to feed the fry, the powder of dried shrimp or fish is used, scattering the powder on the water surface.

The liberation of the fry is very simple. If the screen in the gate at the end of the pond is removed the fry can go down the Chitose River through the channel which is connected to the river. The liberation season extends from about April to the middle of June. The total number of fry are released in about four groups during this season.

The usual percentage of survival from the egg stage to the time of liberation is about 93 per cent, out of which the hatching percentage is 94 per cent or so.

According to the investigations of Mr. Y. Handa, the age of maturity at which salmon return to the Chitose River is from 2 to 5 years. The percentages of each age group are as follows:

2 years old	very rare
3 years old	1.5 per cent
4 years old	63.9 per cent
5 years old	34.6 per cent

It is said that the estimated effect on the commercial run of salmon in the Chitose River from the operation of the Chitose Hatchery is about 0.42 per cent of the liberated fry.

MADISON, WISCONSIN.- Since the War Department constructed the dams for the protection of the 9-foot channel on the Upper Mississippi River, the Bureau's operations covering the salvage of food fishes have been greatly curtailed. Taking advantage of the considerable acreage below most of the dams which is owned by the Government, the Bureau has established ponds in such areas for the production of bass.

At Genoa considerable success has been attained in the production of bass under artificial conditions. The pond area covers approximately 45 acres, consisting of two ponds. From these two ponds this year there were produced 2,260,000 fingerling bass, ranging in length from 1½ to 3 inches. This is an average of approximately 50,000 fish per acre. The small bass were not given artificial food; however, a plentiful supply of daphnia was provided. Natural food was supplied from the large amount of aquatic vegetation in the ponds.

At LaCrosse a 4½ acre pond produced 146,300 fish of the same species. The LaCrosse pond and the ones at Genoa were stocked with adult fish on a basis of 5 pairs per acre.

LEADVILLE, COLORADO.- By the end of last month over 6½ million brook and a quarter of a million Loch Leven trout eggs had been collected at the Bureau's local hatchery. Between 2½ and 3 million trout eggs, it is estimated, will be collected during the present spawning season.

The egg collections for a period at the Lake San Cristobal field station exceeded last year's take by over 400,000.

Sterilizing Hatchery Water Supplies

THE USE OF LIQUID CHLORINE

AND

POWDERED DERRIS ROOT

By William Hagen, Jr.
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A RECENT epidemic of furunculosis at the Saratoga, Wyoming, station of the Bureau of Fisheries necessitated the disposal of a large number of brook trout fingerlings and some adult stock. An investigation of the possible sources of the disease, which had never before made its appearance at the station, revealed that some factor present in the water supply was undoubtedly responsible. In view of this it was decided to disinfect thoroughly the water supply and all ponds and hatchery troughs, together with equipment. The object of this disinfection was to remove all fish and destroy bacteria in the pond formed by the springs, in the creek carrying the overflow, and in the pipelines to the hatchery. Liquid chlorine was decided upon as the disinfectant, following in general the methods used by Davis (1938).

The spring pond, from which the station receives its water, covers an area of about three and one-half acres. Depth is from shallows of six inches to eight feet, with an average depth of about two feet. Fine mud or silt covers the bottom to a depth of three feet in many areas. Over the bottom, at intervals of every fifteen or twenty feet, springs of various sizes bubble up. The low-lying ground around the pond is honey-combed under the sod with small springs and channels to the pond.

Three pipelines, two 10 inches and one 12 inches in diameter, take out water from over the deepest portion of the spring pond and carry it 3,960 feet to the hatchery intake tank. The fall in the lines over this distance is 3.9 feet.

The overflow creek from the spring pond meanders for a distance of over one mile before it reaches and passes through the hatchery grounds proper. Water directly from the creek is not used for ponds or hatchery, but waste water is passed into the creek, which empties into the North Platte River about two miles below the station. At the outlet from the spring pond the creek is about 150 feet in width, but in the first one-fourth mile it narrows to an average of about 20 feet for the remainder of its course. Rarely is the depth of water in the creek more than six inches, and of the mud less than one foot.

Photograph shows pond being chlorinated.

The Saratoga station is equipped with 108 standard troughs, 5 dirt ponds in series, each averaging about two feet in depth, with a total surface area of 29,800 square feet, two 10 by 100 feet and eight 6 by 60 feet cement ponds.

The first necessary step in the project was to place in the creek, above all pond outlets, a suitable barrier to the upstream migration of all fish. With the very slight fall in the creek it was difficult to find a point where a low dam could be constructed without flooding surrounding pasture land. However, at the upper limit of the station grounds such a point was decided upon where a screen had previously been installed. This was removed and a concrete dam placed. The dam boards were inserted on a slope away from the water flow,and a second set of boards were similarly placed beyond these to form a barrier similar to the so-called "jumping-box" trap. Thus, water over the first set of boards strikes the second set, making it virtually impossible for fish to ascend the dam. Probably most hatchery men are familiar with this type of obstruction to upstream migration.

The plan for the disinfection of the water supply was as follows: Dissolve chlorine gas in the spring pond to a concentration of at least 3 p.p.m. (parts per million). Thoroughly dose the main pipelines with chlorine and disinfect the creek down to the dam. After accomplishing the above the entire hatchery, including ponds and troughs and pipelines to each, was to be treated with chlorine by releasing the gas in the two pipes carrying water from the intake tank directly to the hatchery troughs and to the ponds.

Equipment used for all chlorination, in addition to two 150 pound cylinders of liquid chlorine, included the following: Two fume masks, a flat-bottom punt, an outboard motor, fifteen feet of ordinary garden hose, and a three foot length of three-fourth inch non-galvanized iron pipe, closed at one end, in which a number of holes had been drilled with a No. 19 drill (the smallest size available in the vicinity). Chlorine concentration determinations were made in a Hellige comparator by the orthotolidine method.

According to Davis, "when chlorine dissolves in water, part of it unites with water to form hypochlorous acid (HOCL) and a smaller amount of hydrochloric acid (HCL). The remainder is present as free chlorine. However, in direct sunlight tne hypochlorous acid gradually decomposes into hydrochloric acid with the liberation of oxygen. As soon as the hypochlorous acid begins to decompose more chlorine unites with the water to form acid and the process continues until all the chlorine disappears." Considering the above, and inasmuch as sunlight prevailed during daylight hours, operations in the present instance were started at sundown.

A cylinder of chlorine was placed in the boat. The garden hose, with the perforated pipe attached to one end, was connected to the cylinder. An outboard motor was placed on one end of the boat. Chlorine gas was released through the hose and pipe and broken up by agitation of the water with the motor. Chlorination was begun in the spring pond at the point farthest from the outlet. The boat was moved back and forth across the pond, chlorine-saturated water being forced to all shallows near the banks. This process was continued until the spring pond was completely covered and then the same procedure was begun on the overflow creek, working downstream toward the dam on the station grounds. During these operations a second cylinder of chlorine was placed at the heads of the three pipelines and chlorine gas released in each.

Unfortunately, after treating the creek down about one-fourth mile the water became so shallow that it was impossible to operate the outboard motor. Merely releasing the gas in the water without agitation was unsatisfactory as the gas immediately passed into the air. An attempt was made to thoroughly chlorinate the water at the head of the creek where it left the spring pond with the hope that a suitable concentration would be maintained throughout the mile of creek to the dam. This, however, was not successful.

In addition to the above, it was found to be practically impossible to chlorinate the water in the spring pond directly over many of the springs. Fish were forced from these spots but would immediately go to another spring.

Chlorination of the spring pond and creek was, therefore, not wholly successful. However, pipelines and hatchery troughs were readily sterilized by introducing the gas into pipelines. The ponds were chlorinated in the same manner as the

Figure 1. Partial view of spring pond, showing overfloow creek outlet and take-out box for pipelines leading to hatchery in background

spring pond, a wooden tub being substituted for the boat, with the chlorine cylinder on the bank of a pond and the hose leading out. One man held the floating tub and operated the motor while another held the hose and pipe in position.

In general, the spring pond was chlorinated to a concentration of about 2 p.p.m. with a high reading of 4.5 p.p.m., and no free chlorine present over the larger springs. Chlorine gas introduced into the three 3,960 foot pipelines produced a chlorine concentration of over 4 p.p.m. in the intake tank on the station grounds. Both dirt and cement ponds were readily chlorinated to at least 3 p.p.m. Introduction of the gas into pipes leading to hatchery troughs resulted in a conconcentration of over 5 p.p.m.

At the height of chlorination of hatchery troughs, when waste waters were flowing out of the building and into the creek, chlorine concentration determinations were made of creek water below the hatchery. A concentration of 0.8 p.p.m. was found 200 yards downstream, and no free chlorine at three-fourths of a mile. The creek along this section flows approximately 1,500 gallons per minute.

Following the failure to destroy all fish in the spring pond and in the creek with chlorine gas, and before general hatchery sterilization was begun, it was decided to use derris root powder (standard 5% rotenone) in an attempt to remove the balance of fish from these waters. On the basis of 2 p.p.m. desired concentration it was calculated that 25 pounds of the powder would be needed, following the experiments of Leonard (1938).

Figure 2. Spreading derris root solution with tree sprayer.

The method used in spreading the poison was as follows: Approximately 5 pounds of the powder was mixed with water to form a paste for each batch. This mixture was then poured into a 50-gallon barrel containing about 30 gallons of water. A sprayer designed for use in spraying fruit trees was used to spread the derris root solution. By this method it was possible to spray a circular area, with a diameter of about 60 feet, from one position of the boat.

The same procedure was followed in spreading the derris as was done with the chlorine gas. All of the spring pond was systematically sprayed, and then the boat was poled down the creek to the dam at the edge of the station grounds, spreading the solution over all exposed water enroute.

Chlorine gas was responsible for the destruction of about one hundred fifty fish in the spring pond, while derris root accounted for about three hundred more in the spring pond and in the creek. Three-fourths of the fish recovered were dace and the remainder brook trout. In addition, literally bushels of fresh-water shrimp were killed by both operations. The shrimp were not entirely eradicated from the waters, however.

Upon close scrutiny of the mile of creek and of the spring pond on the day following the introduction of derris, two live dace were seen. The presence of additional live dace was entirely possible because of the abundance of cover in the numerous channels extending under the low sod banks. No brook trout were seen and it is believed that the waters were entirely cleared of this species because of the rapid toxic effect of both chlorine and derris root on the trout.

Of the brook trout recovered after death two were found with lesions. The lesions on one of these fish were characteristic of those found in the presence of furunculosis.

In the removal of fish inhabiting the spring pond and creek derris root was far more effective than chlorine gas, but it is not believed that derris destroyed bacteria. Had the original plan been to use both chlorine and derris root in the sterilization of the water supply the logical procedure would have been first to eliminate fish from the spring pond and creek by using derris root, and then to sterilize the pond waters with chlorine to destroy bacteria. Under conditions similar to those encountered in this work it is recommended that the above procedure be followed. However, few hatchery water systems will present the same difficulties, and especially the numerous inaccessible places in which fish could hide far under the creek and spring pond banks.

Figure 3. Spreading derris root solution in the creek leading from spring pond to hatchery grounds.

Calcium hypochlorite, under the trade name "HTH," was used effectively in removing small fish from those springs in the surrounding ground that were exposed.

Although fume masks were found to be a great convenience in the present operations, gas masks would have been more satisfactory. Masks are a distinct advantage, also, when handling dry derris root powder,to avoid unpleasant irritations of nose, throat and lungs.

In conclusion it is suggested that chlorine gas is not entirely suitable for the sterilization of ponds that cannot be drained, or that have springs entering

them from the bottom, nor for shallow, slow moving creeks or channels, where the gas cannot be released from a depth of several feet or be agitated with a motor or by other means. Derris root powder provides a simple means by which fish can be removed from bodies of water. It is easily mixed and spread, and is very effective. Care should be exercised, however, to prevent possible death of livestock, or blame for coincidental loss, although Leonard states that the concentration of the poison necessary to kill fish is not believed to be toxic to warm-blooded animals.

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DULUTH,MINNESOTA.- The Bureau's hatchery is again cooperating with the Michigan Department of Conservation by the incubating of lake trout eggs that are collected by the State from various fields along Lake Superior and Lake Michigan. The collections from Lake Michigan recently have been larger than usual and to date 39 cases of eggs have been received and placed on trays which practically fill the hatchery with what had been secured by the station's personnel from Isle Royal, Michigan. It is, as yet, too early to determine just what percentage of these eggs will eye up, but it is believed that they are of higher quality than those received last year.

BOURBON, MISSOURI.- There was obtained from the Bureau's egg-collecting station an allotment of 255,200 rainbow trout eggs for the Puerto Rican Government. These eggs, which were consigned to the Maricao Fish Hatchery, were placed aboard the S. S. CAROLYN which sailed from Baltimore on December 20. Previous shipments of this nature have been made every season during the past six years.

Do Muskellunge and Pickerel Interbreed?

SUCCESSFUL HYBRIDIZING IN HATCHERY

SUGGESTS THEY DO

By Samuel Eddy
University of Minnesota

THE MUSKELLUNGE (Esox masquinongy Mitchill) was found originally in a number of widely scattered areas in Minnesota. At one time it was quite common in the Mississippi River from Lake Pepin northward, and today is occasionally caught in the region about St. Cloud and Little Falls. It is present in a number of lakes in several localities in north-central Minnesota and in Lake of the Woods, including certain tributary waters. In no waters does it seem to be very abundant at the present time.

The muskellunge found in Minnesota show three different types of markings. These are the tiger muskellunge, which has a light background with dark transverse bars; the leopard muskellunge, which has a light background with more or less distinct dark spots; and the silver muskellunge, which has a solid light or silvery color without any markings. On the first two types the markings may be faint and partially absent from various regions of the body. On many specimens caught by fishermen, the typical scale development on the cheek (lower half without scales) is frequently found to be altered. Many muskellunge, particularly those of the silver variety, appear with the cheek two-thirds scaled, and frequently completely scaled. As the typical condition in the pickerel (Esox lucius L.) is complete scalation of the cheek, there seems to be a possibility that the muskellunge is hybridizing in nature with the pickerel.

For several years, the Minnesota Department of Conservation has been propagating muskellunge at Nevis, Minnesota. Mr. C. J. Falk, Superintendent of the Nevis Hatchery, claimed he had observed the tiger variety of muskellunge spawning with a pickerel. Mr. Falk also stated that several years ago he obtained only one ripe female muskellunge and could find no males. The female muskellunge was stripped and the eggs fertilized successfully with pickerel milt.

In the spring of 1939, arrangements were made in cooperation with Mr. Falk to strip experimentally and crossbreed a number of muskellunge with pickerel. No leopard muskellunge were obtained. Eggs and milt from the tiger and the silver varieties were crossed with the pickerel and also with each other. Crosses were made between male pickerel and female muskellunge, and female pickerel and male muskellunge, May 6, 1939. The eggs were placed on trays and the hatching completed in jars. Through what was apparently an accident, all the silver muskellunge eggs were lost. The hatching of the hybrid eggs of the tiger muskellunge and the pickerel was successful. Although no accurate percentage was determined, approximately fifty per cent of the eggs were successfully hatched. This was much better than the percentage of survival from the eggs of the purebred tiger muskellunge.

By May 18, the yolk sacs were almost completely absorbed, and on May 20 the young were removed from the hatchery. Some were placed in rearing ponds and nearby lakes.

Several hundred fry of each cross and about 300 purebred fry were brought to the University of Minnesota. Seventy of the hybrid fry were placed in large aquaria; the balance, including the purebreds, were placed in a nearby rearing pond.

The muskellunge kept in the aquaria at the University were fed Daphnia from May 20 to May 25. From May 25 until May 28 they fed largely on Corethra larvae. After this date they refused this diet and were fed on sucker fry, later taking small minnows. They were fed entirely on minnows throughout the remainder of the summer.

The fry grew rapidly, reaching a size of two and one-half inches in four weeks. At the end of eight weeks they were four inches long, and at the end of four months they had reached a standard length varying from ten to twelve inches. Very few losses occurred except through cannibalism. The fry from the very start were exceedingly voracious. When they sighted their prey they would poise and apparrently aim. If the prey moved, they would dart quicker than the eye could follow, snapping it up. Sometimes they would poise and aim at inert suspended particles, but if no motion of the particle resulted they would soon abandon the attempt.

If they were without food for two hours they would slash at each other, severing the tails of the victims. Most of the losses in the rearing aquaria occurred from loss of tails, and when the fishes were removed from the rearing pond a number with severed tails were noted.

After the first four weeks no differences could be detected in the crosses between the different sexes. In the very early stages the female muskellunge-male pickerel cross had more dark markings than the male muskellunge-female pickerel cross. Both of the crosses were heavily barred. Some had the scales absent from the lower part of the cheek, but many showed the lower part of the cheek to be covered partially or entirely by scales. There was no evidence of the characteristic color markings of the pickerel.

The muskellunge which were placed in the rearing pond were removed from the pond September 15. The hybrids in the pond were between eleven and twelve inches standard length. Approximately eighty hybrids were recovered, including a few stunted cripples. Eight purebreds, easily distinguished by their semi-spotted marking, were recovered. They were only between seven and eight inches standard length. Obviously the larger hybrids during the first four months of life had grown nearly twice as fast as the purebreds in the same pond. The hybrid muskellunge reared in the rearing pond had grown slightly faster than the hybrids in the aquaria at the University. A number of specimens were removed to the University aquaria and now, at six months of age, show plainly the tiger markings with a variable condition of the scales on the cheek. The markings are heavier and darker than the markings commonly noted on wild muskellunge. Some of the hybrids have the cheek entirely scaled and others show the cheek to be only partially scaled. A more detailed study of these characters should be made when they have become mature.

The cross breeding of muskellunge with pickerel under natural conditions seems to be entirely possible, judging by the results of this experiment. The possibility of producing larger and faster growing fish through hybridizing seems also to be indicated in this experiment. This agrees with the results of Hubbs and Hubbs (1933) who found that hybrid sunfishes grew faster than either of the parent species. Whether the hybrid muskellunge are fertile or not cannot be determined for several years. Hubbs found that the hybrid sunfishes seemed to be infertile.

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BALTIMORE, MARYLAND.- The difficult problem of tagging juvenile shad 3 to 4 inches long is giving Bureau of Fisheries investigators plenty of headaches. However, progress is being made, for a recent report states that 300 Chesapeake Bay fingerlings were held for a week in a physiological salt solution, tagged with small belly tags, and returned to the solution. At the end of 19 days 250, or 83 per cent, were still living. This is in sharp contrast with the results of earlier experiments in which a maximum of 20 percent survived.

This method, Bureau officials state, will not only be useful for tagging delicate fish but offers some promise in the field of hatchery management, especially where difficulties are encountered in transporting fingerling fish between hatcheries.

QUINAULT, WASHINGTON.- In connection with the collecting of salmon eggs at the local hatchery, all spawned-out fish were split and stored in the cold-storage rooms for subsequent transporting to the Quilcene Unit. There they will be converted into fish meal for use as hatchery feed.

Of the 102 adult sockeye salmon taken in the Falls Creek trap, 16 were returns from fish planted during the spring of 1936. The salmon that were liberated in 1936 were large fingerlings, from the 1935 hatch, and were marked before being planted by the removal of both ventral fins.

Frozen Fish in Hatchery Diets May Be Dangerous

By James S. Gutsell
U. S. Fisheries Experimental Station
Leetown, West Virginia

FOR SEVERAL years a heavy mortality has occurred at times among the trout at the State Fish Hatchery at Hackettstown, New Jersey. This loss was apparently not due to any known disease, but there was evidence that it might be the result of feeding frozen fish. In order to determine whether the fish actually was injurious to the trout, there was arranged, by Dr. H. S. Davis, Mr. Charles O. Hayford, and the writer, a series of cooperative experiments to be run at Hackettstown and at Leetown, West Virginia. Thanks are due to Mr. Hayford and others at this famous New Jersey hatchery for much help and many courtesies extended. Except for one experiment at Hackettstown, in which mixed salt-water fish was used, the fish in the diets was herring or alewife of the genus Pomolobus (as far as known Pomolobus aestivalis). Unfortunately, it proved impractical to run an experiment using fish which had not been frozen and stored.

EXPERIMENTS AT HACKETTSTOWN

Seven hundred large yearling brook trout were used in each experiment. Herring (Pomolobus) was included in the diet in three experiments and mixed fish in one. Besides these, two diets fed to other lots were used as controls. The trout were counted and weighed at approximately monthly or four-weekly intervals. Losses were determined solely from these counts. The various diets including fish and their controls were as shown in Table 1.

Lot No. 4 was used as a control for No. 2 and No. 3; Lot No. 6 as a control for No. 5. The diet given Lot No. 1 was the regular hatchery diet some months before the experiments were begun.

These experiments were begun April 1. In July it became evident that all was not well with the lots being fed fish. The trouble that developed was described by Robert A. Hayford as follows: "They first show up as being very black, in comparison with the other trout in the pool, and after a time they become fungused, in some cases very fungused, and then die. A great many of them turn blind." This description is taken from a letter dated July 18, 1938, in which it is estimated that there were then seventy-five to one hundred black fish in Lot No. 5 and that five to fifteen of these black fish were dying daily. At this time the trouble evidently was just making its appearance in the three other lots being fed fish. Three or four fish in each of these lots were said to be turning black and acting much the same as those in Lot. No. 5. Fish was omitted from the diet of Lot No. 5 shortly after this. Although mortality continued for some time, the appearance of the fish soon improved, because they stopped turning black. About a month later (August 22, 1938) a great many blind and black fish were reported among the fish of Lots 1, 2, and 3, and after the next weigh day (August 25) they received no fish in their diets. The fish soon ceased to turn black, although mortality continued, as with Lot. No. 5.

Table 1. Diets Used in Hackettstown Experiments

Lot	Diet	
No. 1	Sheep plucks	58.0 per cent
	Herring	24.0 " "
	Tomato pumace	3.5 " "
	Dried buttermilk	3.5 " "
	Alfalfa meal	3.5 " "
	Fish meal	7.0 " "
	Cod liver oil	0.5 " "
No. 2	Sheep plucks	50.0 per cent
	Herring	50.0 " "
No. 3	Sheep plucks	50.0 per cent
	Mixed fish	50.0 " "
No. 4	Sheep plucks	100.0 per cent
No. 5	Sheep plucks	40.0 per cent
	Herring	40.0 " "
	Meat meal	10.0 " "
	Dried buttermilk	10.0 " "
No. 6	Sheep plucks	60.0 per cent
	Meat meal	20.0 " "
	Dried buttermilk	20.0 " "

It should be noted that Lot No. 5, in which the trouble first appeared and was much the worst, was located in the pool immediately above Lot No. 6, in which this trouble did not appear and where the loss was least. None of the pools where the trout were fed fish and where the black fish trouble appeared were located below Lot No. 5. Examination of the affected fish failed to reveal any evidence that this trouble was due to infection by a disease organism.

In spite of some anomalies, it seems evident that this turning black and becoming blind and fungused and finally dying, was due to fish in the diet, and, therefore, that the use of fish, at least of salt-water fish which have been frozen and stored, as food for trout is attended with grave danger.

The losses in the various Lots were as follows: No. 1 (herring, 24 per cent), 119 (17 per cent); No. 2 (herring, 50 per cent), 182 (26 per cent); No. 3 (mixed fish, 50 per cent), 81 (11.6 per cent); No. 4 (straight plucks), 95 (13.6 per cent); No. 5 (herring, 40 per cent) 376 (53.7 per cent); and No. 6 (no fish in diet), 47 (6.7 per cent). It will be noted that the loss was greatest where the first and worst case of "black fish" was reported and that the smallest loss was in the control experiment. So far so good. However, the loss in Lot. No.2 where a higher proportion of herring was used than in No. 5, was only half that in No. 5. Moreover the loss in No. 4 (plucks) was greater than in No. 3 (which received mixed fish instead of herring but where the "black fish" trouble was reported definitely present). It is quite evident that something else was taking toll of the fish in these pools. The loss in three or four experiments not here under consideration ranged from seventy-seven to eighty-seven. In the other, an

overfeeding experiment, the loss was 148. Under the circumstances, the loss in No. 3 may be considered normal and the loss in No. 1 above normal. Thus the continued use of as little as 24 per cent of stored herring (Pomolobus) in the diet of brook trout seems to bring about a pathologic condition characterized by the very dark coloration of the affected individual ("black fish") and to cause undue mortality. An increase in the proportion of the herring to 40 per cent of the diet is sufficient to cause a disastrous loss. The use of other small, salt-water fish to the extent of half of the diet also seems definitely responsible for the same sort of trouble but to cause comparatively little mortality. Perhaps the trouble develops more slowly than it does from herring.

A great difficulty in interpreting these results lies in the uncertainty as to how long the fish in the various lots may have been on a herring diet, etc. Thus, when the experiments were planned some months before they were started, the diet here employed in Experiment No. 5 was in extensive use at Hackettstown. Moreover, variations had been made from time to time. This previous feeding of herring to the fish used in these experiments doubtless explains, at least in part, the development of the trouble so much sooner at Hackettstown than at Leetown. Another factor may have been the difference in susceptibility of the two species of trout, for at Hackettstown it was stated that brook trout suffered more than rainbow from the fish diet.

Besides the question of healthfulness or unhealthfulness of a diet there is that of its effect on growth. In the matter of efficiency in growth production, as judged by the pounds of food required to produce a pound increase in the weight of the fish, the diets containing fish were not as good as those without fish (4.06 - 4.65 pounds as compared with 3.73 - 3.93 pounds). However, if the cost of food to produce a pound of trout be taken as the criterion and if the probable weights of the lost fish be included, then the showing made by the diets containing fish was comparatively good ($0.215 - $0.261; or if No. 1, which had no control, be omitted $0.215 - $0.233 as compared with $0.231 - $0.314). If allowance is not made for the loss, this cost of fish flesh production was higher than in the controls; in the case of Lot No. 5, very high (see Table 2).

Table 2. Results of Hackettstown experiments pertaining to the use of fish in diets of yearling brook trout.

Lot	Pounds of food to produce pound of growth		Cost of food to produce pound of growth		
	Incl. losses	Based on final weights	Incl. losses.	Based on final weights	Losses
No. 1 Hayford's diet	4.48	5.30	$0.261	$0.315	119
No. 2 50 per cent herring	4.06	6.00	0.215	0.352	182
No. 3 50 per cent mixed fish	4.37	4.41	0.233	0.242	81
No. 4 Straight plucks	3.93	4.60	0.314	0.368	95
No. 5 40 per cent herring	4.65	15.70	0.231	0.816	376
No. 6 Control for Diet No.5	3.73	4.05	0.231	0.251	47

EXPERIMENTS AT LEETOWN

Diets Nos. 1, 5 and 6 were also tried at Leetown. Diet No. 1 was fed to 2-year-old rainbow trout (150 trout in 22-foot circular pool). Regular feeding, six days a week, was begun March 3 and continued until October 26. Feeding during the spawning season was less frequent. The fish were counted and weighed at approximate monthly or four-weekly intervals until October 27.

There was no indication of any tendency of these fish to turn dark or that they suffered any ill effects from the diet. The mortality recorded up to the time of the final weighing on October 27 was three fish (2 per cent) and from that date to February 17, there were nine deaths. This was a lower mortality than for other lots of 2-year-old rainbow trout.

The amount of food to produce a pound of trout growth was less than in other experiments with 2-year old rainbows, but the cost was somewhat more than for a diet 40 per cent of which was seal meal. Both lots consisted of very handsome fish. Egg production from Lot No. 1 was very good, and the proportion of eyed eggs (90.2 per cent) the finest among all lots of fish.

Diets Nos. 5 and 6 were fed to separate lots of yearling trout in 12-foot circular pools. At the start, in each lot there were sixty-five rainbow and sixty two brook trout. Experimental feeding was begun March 28. On June 17, the brook trout were removed. Up to this time, there had been no mortality in either pool, nor any indication of unhealthy fish. Although all calculations of amounts and costs of food to produce a pound of growth are based on feeding and growth after June 17, it is important that the feeding of the diet containing herring, and of the control diet, began not in June but in March. The final weighing was November 3. Reduced feeding was continued during the spawning season.

Up to November 3, only three dead fish had been found in Lot No. 5, against one in the control (Lot No. 6). However, dark fish soon began to be noticeable in Lot No. 5, and thereafter mortality among them was impressive. From November 4 to February 17, twenty-five deaths were recorded, as compared with four in the control. Moreover, even if the mortality had not been clearly significant, the numbers of "black fish" and the almost continuous presence of fish in distress would have been sufficient to show that something was very much wrong with the fish being fed the high (40 per cent) proportion of herring.

This illustrates the need for caution and particularly the need for continuing feeding experiments for a sufficient length of time, as for more than seven months in this case. If this test had not been continued, insofar as was practicable, beyond the time chosen for its termination, the conclusion would hardly have been escapable that this diet, 40 per cent of which was stored herring, was not harmful to rainbow trout, at least under conditions prevailing at Leetown.

The fish in Lot No. 5 made better growth than those of the control and required slightly less food to produce a pound of growth (5.19 pounds as compared with 5.30 pounds). The cost of food to produce a pound of growth, up to November 3, was very much less ($0.299 as compared with $0.390). Egg production was somewhat higher in No. 5 (1,731 as compared with 1,547 eggs per spawner), and the proportion of eyed eggs considerably higher (75.9 per cent as compared with 68.2 per cent).

SUMMARY

1. Six experiments were run at Hackettstown and three at Leetown. From these experiments it appears that the inclusion of frozen and stored fish in the diet of trout produces good growth and with rainbow trout helps to produce good yields of eggs of superior quality, but that there is danger to the health of the fish from its continued use:

2. For yearling brook trout, 40 per cent of herring (Pomolobus) in the diet was very destructive, causing trout to turn black, become fungused and frequently blind, and eventually to die in large numbers. With as little as 24 per cent, this trouble also developed and caused loss.

3. For rainbow trout it appears that 24 per cent of herring is safe, but that 40 per cent produces a similar condition to that produced in brook trout after seven months' continuous use.

4. An experiment, in which mixed salt-water fish replaced the herring, suggests that the latter may be especially harmful. Unfortunately, it proved impractical to test the effect of fish which had not been frozen and stored.

GREAT FALLS, MONTANA.- Work on the new fish cultural station now being constructed in the Glacier National Park in cooperation with the National Park Service, W.P.A. and P.W.A. has been temporarily suspended, but will be resumed as soon as conditions permit. The Bureau will operate the hatchery upon completion. The Foster-Lucas ponds are now ready for use, and the foundations and floor of the hatchery building, with the necessary drains and gutters installed, have been poured.

BOZEMAN, MONTANA.- Seasonal distribution was completed for 1939 for the Bureau's local hatchery with the allotting of 15,000 grayling fingerlings No. 3 to the Idaho State Fish and Game Commission. Forty thousand of this species and 60,000 rainbow trout fingerlings are being retained by this hatchery for distribution in the spring.

PORTLAND, OREGON.- Eighteen million chinook salmon eggs collected recently from Spring Creek and the Big White Salmon River are being incubated now at the Big White Salmon, Washington, hatchery. Owing to the limited space in this hatchery, a quarter of the 24½ million eggs collected were transferred to the Carson and Little White Salmon stations for incubation.

Comments From Our Readers

FISH-CULTURE DOESN'T END AT THE HATCHERY

Editor, Progressive Fish-Culturist
Bureau of Fisheries
Washington, D. C.

Dear Sir:

We practical fish-culturists (spelled with a hyphen) will without doubt be greatly impressed by the work of such men as Surber and Meehean, as displayed in issue number 47 of the PROGRESSIVE FISH-CULTURIST. These developments will no doubt greatly increase the production of fingerling bass on our pond stations.

An important question now enters my mind as to whether or not proper disposition is being or will be made of these fish after they leave the hatchery. As it has been some time since such an article has appeared, it is suggested that a few reminders at this time would be a help. The least of us must realize that proper planting of fish is the most important step in the whole procedure.

Eschmeyer has reluctantly given us in the same issue something to think about as to what, when and where to plant, but some of us could bear being told how.

If we follow closely the trend of thought suggested by some developments in conservation, the fallacy of a great deal of our propagation program will become apparent unless all of the component parts of the program are successfully carried out. Just as any manufacturer is interested to know that his product is consumed by a satisfied customer, it is obvious that we also must follow the results of our propagation program to the sportsman's creel, the market, or the canning factory. I suggest that superintendents and others in charge of stations should not consider their season's job well done simply because they clear their files of applications.

J. Q. McGee
U. S. Bureau of Fisheries
Welaka, Florida

Notes and News

A SHORT COURSE FOR FISH HATCHERY FOREMEN

By Matt L. Ryckman and Francis P. Griffiths
Oregon State Game Commission

FOR THE PAST three years the Oregon State Game Commission has cooperated with Oregon State College in giving a four or five day short course for the foremen of the sixteen game fish hatcheries. The following brief description of this type of conference may be of interest to readers of The PROGRESSIVE FISH-CULTURIST.

The idea of the Game Commission in authorizing the attendance of its hatchery foremen at Oregon State College was to develop a coordinated plan of instruction and discussion of hatchery problems which would aid the men in hatchery operations and in public contacts. Besides the facilities available at the college for instruction, material was brought from, and field trips taken to, the Alsea fish hatchery, which is located 25 miles from the school. The work has concerned itself with trout culture almost exclusively.

An attempt has been made to concentrate on the problems of major importance to the men. In this connection there have been talks on nutrition and discussions often quite animated, on hatchery feeding, laboratory work and lectures on the commoner fish parasites and in elementary bacteriology and hatchery sanitation. The scope of the work is best explained by a glance at the following program.

Program
Third Annual Oregon State Game Fish Hatchery Foremen's
Short Course. Oregon State College, Dec. 4-8, 1939.

Monday:	
8:30	Registration.
9:00 - 10:00	Physiology of reproduction of fish. Dr. Taylor.
10:00 - 12:00	Bacteria and their relation to fish hatchery work. Professors Copson and Simmons.
1:15 - 3:00	Diseases of fish. Dr. Shaw.
3:00 - 5:00	Classification of Oregon trout and salmon. Mr. Dimick.
7:30	Talks by Mr. Wilson, Mr. Ryckman, Dr. Griffiths.
Tuesday:	
8:30 - 9:30	Disinfectants and cleanliness in the hatchery. Dr. Griffiths. Discussion.
9:30 - 10:30	Factors involved in proper fish distribution. Mr. Dimick.
10:30 - 12:00	Costs of raising fish. Discussion led by Mr. Mangold and Dr. Griffiths.
1:00 - 5:00	Trip to Alsea hatchery. Demonstration of grading fish. Weighing of graded fish.

Wednesday:

8:30 - 10:00	Comparison of fish anatomy. Dr. Taylor.
10:00 - 12:00	Bacteria concerned in hatchery practice. Professors Copson and Simmons.
1:30 - 3:00	Hatchery capacity and effects of crowding. Free-for-all discussion.
3:00 - 3:30	Measuring eggs and problems in egg losses. Discussion.
3:30 - 4:30	Shrinkage and unseen hatchery losses. Discussion.
4:30 - 5:00	Principles of fish selection and breeding. Mr. Dimick. Discussion.

Thursday:

8:30 - 10:00	Weighing fish for planting. General discussion of methods.
10:00 - 12:00	Hatchery projects. Setup of projects for various hatcheries.
1:30 - 3:00	Recent developments by the U. S. Bureau of Fisheries in fish feeding. Mr. Fred Foster, U. S. Bureau of Fisheries.
3:00 - 5:00	Fish hatchery feeding. Facts and Fancies. Dr. Lauren Donaldson, University of Washington. Discussion.
7:30	What the experimental stream has shown and can show us about fish. Dr. Needham. Game Commission pictures. Mr. Wire.

Friday:

8:30 - 10:00	Comparative anatomy of trout, perch and catfish. Dr. Taylor.
10:00 - 12:00	Bacteriology. Professors Copson and Simmons.
1:30 - 2:30	Trout stream foods and their relation to fish planting. Dr. Needham.
2:30 - 4:00	Pitfalls in raising fish. Dr. Donaldson and Mr. Foster.
4:00 - 5:00	Prevention of fish diseases. Dr. Griffiths.

The men have been quite enthusiastic and cooperative during all three courses. One of the major benefits has been the exchange of ideas and methods which has resulted from the group meetings. In many instances the instructors have received as much instruction as those instructed. One result of the meetings has been the organizing of hatchery problem projects by means of which facts and data of value to the group may be sought at several hatcheries and the results recorded and compared at the next meeting.

Oregon has been fortunate in the cooperation which it has received from the U. S. Bureau of Fisheries and the aid and interest which the Bureau's men have given this course. The presentation by Dr. Donaldson of the University of Washington and Mr. Fred Foster of the latest information and methods of feeding salmonoid fishes was of particular value. Dr. Paul R. Needham gave the short course a very informative talk on trout stream insects and the role they play as food for wild trout. The State College's Department of Fish and Game Management was active in sponsoring the meetings and placed its laboratory and lecture room facilities at the disposal of the group.

GREAT LAKES FISHES PLANTED IN SOUTH AMERICAN LAKE

ON FRIDAY, January 26, Sr. Joaquin Alejandro Cortez, Chief, Division of Animal Husbandry, Bureau of Animal Industry, Peru, sailed from New York via the S. S. SANTA CLARA of the Grace Line enroute for Puno, Peru, with a consignment of fish eggs destined for the restocking of Lake Titicaca.

Swept by bone-chilling winds in a region where the air is so intensely keen and cold that horses cannot work, Lake Titicaca lies 12,500 feet above sea-level in the Andes mountains bordering Peru and Bolivia. The highest steam-navigated lake in the world, and covering 4,500 square miles (an area almost equal to that of Connecticut) it is fed by glacial streams; but its water never reaches the sea, for it flows into a salt marsh where it is absorbed or evaporates.

The eggs consisted of approximately two million whitefish eggs obtained from Lake Erie and several hundred thousand lake trout eggs furnished by the Bureau of Fisheries hatchery at Cape Vincent, New York. The whitefish eggs were obtained through the cooperation of the Division of Conservation of the State of Ohio. The State of Ohio and the Bureau of Fisheries operate a hatchery at Put-in-Bay, Ohio, on a cooperative basis.

The impetus to this shipment developed in 1936 when Milton C. James, Assistant Chief of the Division of Fish Culture of the U. S. Bureau of Fisheries, made a survey of Lake Titicaca. The objective was to determine the possibilities of making the lake more productive economically either by the culture of native fishes or by the introduction of foreign forms. The very limited natural fish fauna present appeared to offer slight possibilities for profitable fish cultural work, but a study of chemical, physical, and biological conditions indicated that the lake was of a type which would permit the survival of practically any of the species native to our great lakes. It was ascertained that conditions were favorable for such valuable food fish as the whitefish and lake trout. The Peruvian and Bolivian Governments, in whose territory the lake is located, established a joint commission, which constructed the Chucuito fish hatchery for the purpose of incubating these eggs.

A trial shipment of lake trout eggs was made last winter but owing to insufficient time for preparation, the outcome was not favorable. As a consequence, Sr. Cortez made a special trip to this country in order that the eggs could be given all necessary attention on the return trip.

Some fourteen days after the SANTA CLARA sailed the eggs were to be laid down in the new hatchery. It is expected that they will hatch sometime during March or April and the young fish will subsequently be liberated at various points in Lake Titicaca. The present fish population in the lake is extremely limited and it is hoped that after five or ten years, the time required for the successful outcome of this experiment, the residents of the High Andes will be able to dine on one of the choicest fishery products of the American Great Lakes.

This is the second consignment of lake trout eggs shipped to South America during the present season. In late December a consignment of lake trout eggs was forwarded to Argentina by the Michigan Conservation Department. The State of Michigan undertook to supply these eggs as a courtesy and token of good will when a request of the Argentine Government was transmitted through the Bureau of Fisheries.

NEON LIGHTS ATTRACT INSECTS TO TROUT PONDS

SUBMERGED red-and-green neon lights to guide insects to a surer death have been installed as the newest type fish-food lure in the field of Federal trout hatcheries.

Although the use of light to attract flying insects to trout and other rearing ponds is nothing new, these novel colored subsurface beacons, now in use at the Spearfish (South Dakota) Station of the Bureau of Fisheries, have never been tried out elsewhere. Heretofore, hatcheries utilizing the light principle to supplement ordinary feeding procedures, have depended upon a simple drop-cord ending in a wide reflector from six to eight inches above the water surface. Seeing the reflected glow, insects strike for the surface where they are captured by the fish.

Just what poundage of flying food has been recovered through the use of ordinary lights, or may be recovered by the new type, is not known. In any event, the procedure of using lights as a lure has been used in many hatcheries with apparently favorable results.

The new type submarine lures, perfected by J. F. Harrington, present foreman, and T. S. Kibbe, former foreman, of the Spearfish hatchery, are an improvement over the ordinary type light lures. Each of the slender neon tubes, about four feet in length, is equipped with specially developed underwater wiring and waterproof fittings. The red and green colors were not chosen with any thought that one might be more attractive than another to the insects, although it may be learned from the experiment that they actually have a preference.

This innovation is the second "notable first" for the Spearfish station. In the winter of 1937-38, this station was first among all fish hatcheries to begin experiments with the heating of water in the incubation of trout eggs in order to get larger and stronger fish in a shorter time.

CARSON, WASHINGTON.- Considerable trouble was again experienced with the so-called "slime" which at times prevented the proper circulation of water necessary for eyeing the green eggs at the local Bureau hatchery where several thousand chinook salmon eggs are being carried.

The trays on which these eggs are being carried are covered with 12-mesh screen, and it is believed that the utilization of a larger mesh, about 3/16 of an inch, for eyeing the eggs will overcome this difficulty. However, after the eggs are eyed it will be necessary to transfer them to trays with a smaller mesh in order that when they hatch the fry's sac will not drop through the openings.

Reviews

THE WESTERN ANGLER, an account of Pacific Salmon and Trout
By Roderick L. Haig-Brown: Two Volumes, Vol. I - 200 pp.:
Vol. II - 192 pp.: Derrydale Press, New York, 1938. $25.00 set.

IT IS A REAL pleasure to review this well-written and attractive account of Pacific salmon and western trout recently published by the Derrydale Press, under the authorship of Roderick L. Haig-Brown. Though only in his early thirties Mr. Haig-Brown has long been delving into fisheries matters. Reared and schooled in England, he came to the Pacific Coast in 1926 and finally settled on Campbell River, Vancouver Island, where he now makes his home. Primarily a writer rather than a fisheries investigator, his first fish book, "Silver, the Life Story of an Atlantic Salmon," was published in 1931. "Pool and Rapid, The Story of a River," (The Nimpkish) was published in 1932, and "Ki-yu;" a fairly accurate, but fictional, account of the Vancouver Island cougar, was published in 1934.

His interest in authoritative information on fishes early led him to contact the fisheries research staff at the Pacific Biological Station at Nanaimo on Vancouver Island. Haig-Brown acknowledges the aid of Dr. W. A. Clemens and other members of the staff at that station in the preparation of THE WESTERN ANGLER. Dr. C. McC. Mottley, formerly a staff member at Nanaimo and now at Cornell University, has written a Foreword in which he says: "Mr. Haig-Brown has kept in touch with a large number of specialists in the fishery field and has the happy faculty of being able to draw together their most recent findings in such a way that they have a glow of meaning for the ordinary angler." This is the unusual feature of THE WESTERN ANGLER in contrast to most books prepared for fishermen. While it does tell how to catch fish, by far the bigger portion is devoted to the conservation of fish life based on facts discovered by various investigators. While a few speculations are given, most of these are stated cautiously.

Volume I is divided into three parts. Part I covers the trout and salmon of British Columbia waters, with a discussion of general angling problems in that region. Part II discusses fisheries problems common to the interior of British Columbia. In this section Dr. Mottley's work on Paul Lake is discussed in considerable detail. The danger of overstocking lakes is clearly brought out as are other pertinent management problems relating to survival of planted trout, natural spawning conditions, seasons, bag limits, foods, and other factors that affect angling.

Chapter 10 of Part II gives a discussion of the aquatic animals common to interior British Columbia waters and comparisons have been made with English chalk-stream conditions. The last part of this section is devoted to a discussion of tackle and general angling tactics.

Part III discusses both conservation and angling problems in relation to steelhead and migratory and non-migratory cutthroat and rainbow trout.

One of the finest features of Volume I is the excellent series of seven colored plates of the various kinds of trout found in British Columbia waters. These are not original plates, but are those prepared by Mr. E. B. S. Logier of the

Royal Ontario Museum of Zoology, Toronto, and were first published in THE TROUT AND OTHER GAME FISHES OF BRITISH COLUMBIA, by G. R. Dymond, in 1932. The Frontispiece of this volume is a colored plate showing 20 different types of wet flies used for stream and lake fishing in British Columbia waters.

Volume II is divided into parts IV and V. Part IV is entirely on Pacific salmon and, in seven chapters, covers species, migrations, propagation, angling methods, weights, and general notes and experiences.

Part V relates largely to predators, diseases, tackle, equipment, limits, ethics, and general angling and conservation problems.

The section on predators is sensible and well balanced. Instead of demanding destruction of every form of animal life that might eat game fish, as is often done by the lay angler, Haig-Brown states that extermination is not to be recommended though control measures may often be necessary in the vicinity of hatcheries and rearing ponds. Making reference to recent studies on the American Merganser by Munroe and Clemens in British Columbia, he says that the findings of these workers show that, "the American Merganser in its present abundance is not a menace to commercial and game fish," in British Columbia waters.

There are two appendices, one on British Columbia fly dressings and one giving Knut Dahl's method of estimating survivals and fish populations of lakes as applied by Dr. Mottley. This volume contains one colored plate as a Frontispiece, showing various types of flies used for trout, steelhead, and salmon.

Both volumes are well illustrated with excellent photographs of British Columbia fishing waters and a few line drawings of fish and aquatic insects. The typography is clean and clear on heavy rag paper, and the red cloth binding in quarto size makes an extremely attractive pair of volumes.

Such a work as this should certainly have a wider distribution than its price ($25.00 per set) is going to permit. Only 950 copies were printed which is an additional limiting factor. This is the type of work that anglers and sportsmen will read without having it forced down their throats as is often the case where scientific facts are presented in the usual dry, academic manner. The reviewer feels that this book is of sufficient importance to warrant a much cheaper reprint after some condensation. THE WESTERN ANGLER could be "boiled down" considerably without hurting its essential value a bit. Indeed, this would improve it from the standpoint of organization and make it easier to use. None of its interest would be lost and it would form an extremely useful reference book for fish men generally.

In conclusion, the reviewer agrees with the author, who said in a letter, "It (THE WESTERN ANGLER) is a handsome creature on the shelves and if it does a bit of work toward better fishing and better enjoyment of fishing, I shall feel pretty good about it." The author has good reason to "feel pretty good about it," and so should anyone else who has the two volumes on his shelves.

P. R. Needham
U. S. Bureau of Fisheries
Stanford University, California

ANGLING IN AMERICA: ITS EARLY HISTORY AND LITERATURE
By Charles Eliot Goodspeed
Houghton Mifflin Company, 1939, 380 pp. $15.00

"ANGLING IN AMERICA" by Charles Eliot Goodspeed, of the famous Boston bookshop family, is already a collectors' item. It is the kind of book that will make fish-culturists forget for the time being about feeding charts, fish diseases, hidden mortalities, growth rates and the other headaches which keep us behind the eight ball in this peculiar business.

What will you find in the book? First, of course, the history of angling chronologically presented. The author makes a clear distinction between "angling" and "fishing," pointing out that the native American Indian was only a fisherman, taking his fish by means of spears or nets.

Although angling was introduced to America in 1690 by Richard Franck, a fishing pal of Izaak Walton, it did not become a part of our culture until fishing clubs were organized some fifty years later. The first club, the Schuylkill Fishing Club of Philadelphia, is still in existence and celebrated its 200th anniversary in 1932.

American fishing literature has no counterpart of Izaak Walton. Many of our early writers, however, have references to angling. Thoreau, Washington Irving, James Fenimore Cooper, Horace Greeley, and Daniel Webster are cited. Even Audubon wrote about the joys of catfish and perch fishing.

It is typically American that a New York City fishing tackle manufacturer's catalogue furnished American anglers with their first manual. Later Thaddeus Norris, a fish-culturist, contemporary of Fred Mather and Seth Green, published "The American Anglers Book." It was the beginning of a never-ending caravan. Hardly a month now passes without a new fishing book being added to the list.

An excellent chapter on tackle and its development will interest scientist and sportsman alike.

No book on fishing would be complete without a chapter of "fish stories." We thought we detected a noticeable Puritan restraint in their presentation.

Of inestimable value is the accompanying check-list of every publication on angling, including books and magazines published in America.

In the opinion of the reviewer, no book on the subject has been written with a greater sincerity of purpose, more craftsmanship or in such a gracious, dignified style.

Those who love books and are susceptible to their spell will find this volume one of the happiest events of our time.

Cecil Heacox
State Fish Hatchery
Rome, New York

Supplement

ORGANIZATION AND DIRECTORY OF EMPLOYEES
U. S. BUREAU OF FISHERIES

The Bureau of Fisheries is concerned with the conservation of fishery resources and with the promotion of trade and commerce in fishery products. The functions of the Bureau are administered by five divisions.

The Division of Scientific Inquiry conducts biological investigations to determine the condition of fishery resources of the Atlantic, Gulf and Pacific Coasts, studies the causes of fluctuations in abundance of food fishes and develops methods of husbanding these resources, including improvements in methods of fish culture and the determination of safe rates of withdrawal by the commercial fisheries.

The Division of Fish Culture propagates and distributes food fishes, rescues fishes from overflowed lands and distributes such fishes to suitable waters.

The Division of Fishery Industries studies the methods of the fisheries and of the preservation, utilization and merchandising of fishery products, collects and compiles statistics of the fisheries, administers the Act authorizing associations of the producers of aquatic products and conducts a fishery market news service.

The duties of the Alaska Division include the protection and conservation of the salmon and other fisheries of Alaska, the administration of the fur seal herd of the Pribilof Islands and the care of the natives of those islands.

The Law Enforcement Division is responsible for the enforcement of the Act of July 2, 1930, regulating the interstate transportation of black bass and for the administration of the Whaling Treaty Act of May 1, 1936.

The following directory indicates the organization and personnel of the Bureau of Fisheries as of February 15, 1940. At that time the number of permanent employees in all branches of the Bureau's service was approximately 700.

WASHINGTON HEADQUARTERS OFFICE

OFFICE OF THE COMMISSIONER

(Vacancy), Commissioner
Charles E. Jackson, Deputy Commissioner, (Acting Commissioner)
Joan C. Krentzlin, Secretary to Mr. Jackson

ADMINISTRATIVE DIVISION

John R. Gardner, Administrative Assistant
Dorothy F. Robinson, Secretary to Mr. Gardner

Accounts Section

John R. Van Houten, Chief
Margaret C. Cameron, Assistant
George G. Davies, Payroll Clerk
Nora M. Anderson, Assistant Clerk
Muzette Medlock, Assistant Clerk
Nina Wyant, Assistant Clerk
Ruth Z. Curtis, Junior Clerk-Stenographer
Britt, Y. B., Junior Clerk
Hantzman, W. H., Junior Clerk
Harbeck, Robert B., Assistant Messenger

Personnel Section

Belle B. Butler, Assistant to Administrative Assistant
Catherine W. Colford, Ass't. Clerk-Stenographer
Dorothy W. Harbison, Junior Clerk-Stenographer

Informational Service

Don Bloch, Informational Service Representative
Dorothy A. Farrell, Secretary to Mr. Bloch

Editorial Section

Harold B. Carr, Principal Editorial Clerk
Barbara B. Aller, Senior Clerk

Publications Section

Edna N. Sater, Publications Clerk

Library

Gladys Johnson, Librarian

Mails and Files

Edna S. Coffin, Senior Clerk
Morris R. Facer, Junior Clerk
Joseph F. Healy, Assistant Messenger

Requisition Clerk

George F. Hughes

DIVISION OF SCIENTIFIC INQUIRY

Elmer Higgins, Chief
Edward W. Bailey, Assistant Chief
Dr. Samuel F. Hildebrand, Senior Ichthyologist
Isaac Ginsburg, Assistant Aquatic Biologist
Margaret B. Murphy, Secretary to Mr. Higgins
Eunice C. Underwood, Assistant Clerk-Stenographer
Walter M. Bosworth, Assistant Clerk.

LAW ENFORCEMENT DIVISION (Black Bass and Whaling)

Talbott Denmead, Law Enforcement Officer
Esther E. Dodd, Law Clerk

DIVISION OF FISHERY INDUSTRIES

Reginald H. Fiedler, Chief
Fred F. Johnson, Assistant Chief
Rose Lee Rainey, Secretary to Mr. Fiedler
Mary R. Berens, Secretary to Mr. Johnson
Flora E. Erikson, Ass't. Clerk-Stenographer
Mildred I. Flavin, Ass't. Clerk-Stenographer

Statistics
Edward A. Power, Associate Statistician
Richard T. Whiteleather, Assoc. Marketing Agent
Frances Turman, Secretary to Mr. Power
Melissa M. Tinkey, Assistant Clerk
Elsie M. English, Junior Operator
Katherine P. Jones, Junior Operator.

Field Agents - Headquarters, Washington, D. C.
Colson J. Robbins (Maine and New Hampshire)
Melville J. Fraser (Massachusetts)
Vernon E. Heffelfinger (Rhode Island and N. J.)
Charles H. Lyles (Connecticut and New York)
Rob L. Greer (Maryland)
Leroy S. Christey (Virginia)
Donald Y. Aska (North and South Carolina, Georgia, and the east coast of Florida)
Earl V. Ebner (West coast of Florida, Alabama, Mississippi, Louisiana, and Texas)
Cyrus H. Chilton (Great Lakes)

Fishery Market News Service
Andrew W. Anderson, Fisheries Marketing Specialist
Harry E. Timmis, Fisheries Marketing Agent
Clarence R. Lucas, Fisheries Marketing Agent
Prentiss W. Evans, Junior Fisheries Marketing Agent
Mildred C. Olson, Secretary to Mr. Anderson

Marketing Investigations
Ralph Russell, Associate Fishery Economist
Keith O. Burr, Junior Fisheries Statistician

Technological Investigations
James M. Lemon, Fisheries Technologist (Acting Senior Technologist)
Norman D. Jarvis, Assoc. Fisheries Technologist
Ruth V. Keefe, Secretary to Mr. Lemon

DIVISION OF FISH CULTURE

Glen C. Leach, Chief
Milton C. James, Assistant Chief
Edward J. Douglass, Supt. of Fish Distribution
Helen M. Ganey, Secretary to Mr. Leach
Olive M. Brosseau, Ass't. Clerk-Stenographer
Charles R. Van Horn, Assistant Clerk
Irene E. Kelly, Junior Clerk-Stenographer

Aquarium
Fred G. Orsinger, Director

ALASKA DIVISION

Ward T. Bower, Chief
Seton H. Thompson, Assistant Chief
Ralph C. Baker, Junior Administrative Assistant
I. Florence Chapin, Senior Clerk
Lillian Gruen, Secretary to Mr. Bower
Doyle C. Tripp, Assistant Clerk-Stenographer

FIELD OFFICES 1/

DIVISION OF SCIENTIFIC INQUIRY

Functions--The scientific measuring of fish populations and determination of fluctuations therein, inquiry into causes of depletion and the devising of remedial measures to maintain or rehabilitate the important fishery resources. Research and cooperative planning and supervision regarding fresh water fishery management. Improvement of oyster, clam and other mollusc farming practice and the application of improved methods to commercial operations.

The staff of the Division of Scientific Inquiry consists of 88 permanent employees. In addition, the number of persons employed on a temporary basis may be as high as 75 during the peak of the field season.

1/ The directory of field employees does not include persons in clerical and other supporting positions, nor temporary employees. A statement of the total number of permanent and temporary employees is given under each Division.

North Atlantic Fishery Investigations

Cambridge, Mass., Room A-210 Harvard Biological Laboratories
William C. Herrington, In Charge, Aquatic Biologist
Dr. George A. Rounsefell, Associate Aquatic Biologist
John R. Webster, Assistant Aquatic Biologist
Henry M. Bearse, Junior Aquatic Biologist
Alfred Perlmutter, Junior Aquatic Biologist
Leslie W. Scattergood, Junior Aquatic Biologist (Boothbay Harbor,Me.)
Frank E. Firth, Biological Collector

Middle Atlantic Fishery Investigations

College Park, Maryland, Room FF-14 Horticulture Bldg.
Robert A. Nesbit, In Charge, Aquatic Biologist
William C. Neville, Assistant Aquatic Biologist
Rachel L. Carson, Junior Aquatic Biologist
Edgar H. Hollis, Junior Aquatic Biologist

Charleston, South Carolina, 12 Gillon Street
John C. Pearson, Assistant Aquatic Biologist
Louella E. Cable, Junior Aquatic Biologist

Shrimp Investigations

New Orleans, La., 336 Chartres Street
Milton J. Lindner, In Charge, Associate Aquatic Biologist
W. W. Anderson, Assistant Aquatic Biologist
Charles H. Baltzo, Junior Aquatic Biologist

North Pacific Fishery Investigations

Seattle, Washington, 2725 Montlake Blvd., U. S. Fisheries Laboratory
Dr. Frederick A. Davidson, Director
Edwin H. Dahlgren, Associate Aquatic Biologist
Allan C. DeLacy, Junior Aquatic Biologist
Samuel J. Hutchinson, Junior Aquatic Biologist
Lawrence Kolloen, Junior Aquatic Biologist
Dr. James L. Wilding, Junior Aquatic Biologist
William M. Morton, Junior Aquatic Biologist

Bristol Bay Staff
George B. Kelez, Associate Aquatic Biologist
Joseph T. Barnaby, Associate Aquatic Biologist
Albert Collier, Junior Aquatic Biologist
Robert L. Hacker, Junior Aquatic Biologist
Walter Sands, Junior Oceanographer

Columbia River Staff
Joseph A. Craig, Associate Aquatic Biologist
Arnie J. Suomela, Associate Aquatic Biologist
Mitchell Hanavan, Junior Aquatic Biologist
Zell E. Parkhurst, Junior Aquatic Biologist
John R. Coleman, Assistant Statistical Agent

South Pacific Fishery Investigations

Stanford University, California, 450-B Jordan Hall
Oscar E. Sette, In Charge, Senior Aquatic Biologist
Dr. Lionel A. Walford, Associate Aquatic Biologist
Kenneth A. Mosher, Junior Aquatic Biologist
Ralph P. Silliman, Junior Aquatic Biologist
Earle C. Palmer, Assistant Statistical Clerk

Great Lakes Fisheries Investigations

Ann Arbor, Michigan, University of Michigan, University Museums
Dr. John Van Oosten, In Charge, Aquatic Biologist
Dr. Ralph Hile, Associate Aquatic Biologist
Dr. Hilary J. Deason, Assistant Aquatic Biologist
Frank W. Jobes, Junior Aquatic Biologist

Hydraulics Section

Seattle, Washington, 2725 Montlake Blvd.
Harlan B. Holmes, In Charge, Aquatic Biologist
Olaf W. Lindgren, Associate Hydraulics Engineer

Interior Waters Investigations

Columbia, Missouri, University of Missouri (Mail - 101 Willis Ave.)
Dr. Max M. Ellis, In Charge, Senior Aquatic Physiologist
Dr. Bertis A. Westfall, Associate Aquatic Physiologist

Aquicultural Investigations

Dr. Herbert S. Davis, In Charge, Fish Pathologist, Leetown, W. Va.

Leetown, West Virginia (P. O. Kearneysville, W. Va.)
Eugene W. Surber, In Charge, Assistant Aquatic Biologist
Dr. James S.Gutsell, Assistant Aquatic Biologist
Estelle Citrin, Junior Aquatic Biologist

Stanford University, California, Natural History Museum
Dr. Paul R. Needham, Associate Aquatic Biologist
Dr. Osgood R. Smith, Assistant Aquatic Biologist

Logan, Utah, c/o State Agricultural College
Dr. Stillman Wright, Associate Aquatic Biologist

Pittsford, Vermont
Russell F. Lord, Junior Aquatic Biologist

Pisgah Forest, North Carolina
Thomas K. Chamberlain, Associate Aquatic Biologist

Aquicultural Investigations (Cont.)

Seattle, Washington, 2725 Montlake Blvd.
Dr. Frederic F. Fish, Associate Aquatic Biologist
Robert L. Rucker, Assistant Biological Aid

Welaka, Florida
O. Lloyd Meehean, Assistant Aquatic Biologist

Oyster Cultural Investigations

Dr. Paul S. Galtsoff, In Charge, Woods Hole, Mass. (Headquarters, Wash,D.C.)
Dorothy Hamilton, Junior Zoologist " " "

Beaufort, North Carolina, U. S. Fisheries Biological Laboratory
Dr. Herbert F. Prytherch, Superintendent and Director
Charles Hatsel, Foreman

Milford, Conn., U. S. Fisheries Laboratory
Dr. Victor L. Loosanoff, Associate Aquatic Biologist
James B. Engle, Oyster Culturist
Joseph F. Lucash, Biological Station Foreman

Pensacola, Florida, Box 1826
Dr. Aubrey E. Hopkins, Aquatic Biologist

Yorktown, Virginia, Box 428
Dr. Walter A. Chipman, Associate Aquatic Biologist

LAW ENFORCEMENT DIVISION (Black Bass and Whaling)

Functions--Field work in connection with enforcement of the Federal Black Bass Law which prohibits interstate shipment of largemouth or smallmouth black bass illegally caught, shipped, or sold; the preparation of statistical and biological reports of the operations of whaling companies licensed under the Whaling Treaty Act, and the issuance of whaling licenses.

In addition to the permanent field personnel listed below, approximately 130 State Fish and Game wardens of 30 states are authorized by the Secretary of the Interior to enforce the Black Bass Law as Deputy Black Bass Law Inspectors, serving without compensation from the Federal Government.

Hopkinsville, Kentucky
James T. Hammond, Black Bass Law Inspector

Columbia, South Carolina
C. West Jacocks, Deputy Black Bass Law Inspector

Antarctica (with Byrd Expedition for Whaling studies)
Milton J. Lobell, Junior Aquatic Biologist

DIVISION OF FISHERY INDUSTRIES

Functions--The field work of the Division in general includes the collection of fishery statistics; the collection and dissemination of market news data; the conduct of investigations in technology, economics, marketing, and other sciences, to develop the best possible use of our fishery harvests; and the cooperation with other units of the Federal Government and State and private agencies in these investigations.

The staff of the Division of Fishery Industries consists of 67 permanent employees and approximately 45 temporary employees.

Statistics and Marketing

Seattle, Washington, 421 Bell Street Terminal
*Victor J. Samson, Fisheries Statistical and Marketing Agent
*Francis M. Wood, Junior Fisheries Statistical and Marketing Agent
*(Also shown under Seattle Fishery Market News Office)

San Pedro, California, U. S. Post Office Building
Carl B. Tendick, Fisheries Statistical and Marketing Agent

Fishery Market News Service

New York, N.Y., 33A Fulton Street
William H. Dumont, Senior Fisheries Marketing Agent
Francis J. Anderson, Junior Fisheries Marketing Agent
Walter D. Glidden, Junior Fisheries Marketing Agent
Charles W. Morrison, Junior Fisheries Marketing Agent

Boston, Mass., 253½ Northern Avenue
Burt E. Lindgren, Senior Fisheries Marketing Agent

Chicago, Illinois, 200 North Jefferson Street
Edwin C. Hinsdale, Fisheries Marketing Agent

Jacksonville, Florida, 309 Duval Building
Stacey C. Denham, Fisheries Statistical and Marketing Agent

Seattle, Washington, 421 Bell Street Terminal
Victor J. Samson, Fisheries Statistical and Marketing Agent
Francis M. Wood, Junior Fisheries Statistical and Marketing Agent

New Orleans, La., 1100 Decatur Street
C. Eldred Peterson, Fisheries Statistical and Marketing Agent

Technological Laboratories

College Park, Maryland, University of Maryland
James M. Lemon, In Charge, Fisheries Technologist
Hugo W. Nilson, Assistant Pharmacologist
Samuel R. Pottinger, Assistant Technologist

Technological Laboratories (Cont.)

College Park, Maryland
Charles F. Lee, Junior Chemist
Joseph F. Puncochar, Junior Bacteriologist
William B. Lanham, Junior Chemist
Robert J. Reedy, Junior Bacteriologist
Willis H. Baldwin, Junior Chemist

Seattle, Washington, 2725 Montlake Blvd.
Roger W. Harrison, In Charge, Fisheries Technologist
Maurice E. Stansby, Assistant Technologist

DIVISION OF FISH-CULTURE

Functions--Operates fish hatcheries and rearing stations for propagation of food and game species; procures supplies and equipment and distributes hatchery output upon applications, as Bureau plants, and as allotments to State and other Federal agencies; cooperates with State fish and game departments and sportsmen's organizations in fish distribution; administers fisheries matters in the Upper Mississippi Wildlife Refuge including salvage of fish from overflow areas when necessary; performs necessary work in connection with maintenance of physical plant and equipment and carries on new construction when funds are provided; submits detailed reports on the foregoing activities and special reports and data as required by Washington office; conducts preliminary field surveys and investigations for hatchery sites and rearing units as required; collects eggs from wild fish by trapping, seining, purchase from commercial fishermen, etc., for hatchery operations.

The staff of the Division of Fish-Culture consists of 367 permanent and approximately 100 temporary employees.

List of Fish Hatcheries and Substations

Atlantic Coast and Southern Territory. Headquarters: Under direct supervision of Washington office.

Arcadia, Rhode Island - Floyd A. Chamberlain, Foreman
Berlin, N. H. - Henry Delisle, Acting Superintendent
St. Johnsbury, Vt. - M. E. Hubbard, Fish-Culturist
Boothbay Harbor, Maine - Thos. H. Dorr, Superintendent
Cape Vincent, New York - J. P. Snyder, Superintendent
Barneveld, New York - Ralph C. Jackson, Fish-Culturist
Cortland, New York - A. V. Tunison, In Charge
Craig Brook (P.O. East Orland, Maine) - George N. Montgomery, Superintendent
Edenton, N. C. - W. C. Bunch, Superintendent
Elk River (P.O. Elkmont, Alabama) - F. L. Snipes, Superintendent
Flintville, Tenn. - M. R. Stevens, Foreman
Erwin, Tenn. - G. C. Robertson, Superintendent
Fort Belvoir, Virginia - W. R. Newcomb, Foreman
Gloucester, Mass. - G. L. Davis, Foreman
Hartsville, Mass. - O. L. Montonna, Foreman
Lake Park, Ga. - Chas. B. Grater, Superintendent

Atlantic Coast and Southern Territory (Cont.)

Lamar, Pa. - R. P. Tanner, Superintendent
Leetown (P.O. Kearneysville, W. Va.) - E. W. Surber, Director
Louisville, Ky. - H. O. Hesen, Supt.
Marion, Ala. - Chas. R. Wiant, Supt.
Lyman, Miss. - Dudley B. Heiliger, Fish-Culturist
Tupelo, Miss. - D. E. Bourland, Fish-Culturist
Marianna, Florida - C. D. Flynt, Foreman
Cohutta, Ga. - F. F. Tanner, Fish-Culturist
Warm Springs, Ga. - E. B. Ballard, Foreman
Carbon Hill, Ala. - Luther Henkle, Foreman
Nashua, N. H. - Ernest O. Rodgers, Acting Supt.
Orangeburg, S. C. - P. G. Carnes, Supt.
Hoffman, N. C. - W. S. Hillard, Foreman
Pisgah Forest, N. C. - R. O. Knuth, Fish-Culturist
Pittsford, Vt. - R. F. Lord, In Charge
Rochester, Brighton Station, N. Y. - Henry C. Markus, In Charge
Carpenter's Brook Station (P.O. Elbridge, N.Y.) - A. W. Bugbee, Fish-Culturist
Uvalde, Texas - John Blosz, Supt.
Fort Worth, Texas - A. L. Carlton, Foreman
San Angelo, Texas - Ralph Parish, Apprentice Fish-Culturist
San Marcos, Texas - Arno C. Fuller, Foreman
Inks Dam, Burnet, Texas - Lee Duncan, Acting Foreman
Walhalla, S. C. - A. C. Balch, Foreman
Chattahoochee Forest Station (P.O. Margaret, Ga., c/o CCC Camp F11) - Geo. W. Roff, Apprentice Fish-Culturist
Welaka, Florida - J. Q. McGee, Foreman
White Sulphur Springs, West Virginia - C. H. Van Atta, Supt.
Woods Hole, Mass. - Robert Goffin, Supt.
Wytheville, Va. - S. A. Scott, Supt.
Harrison Lake (P.O. Roxbury, Va.) - Byron Hutto, Fish-Culturist
Norris, Tenn. - Walter M. Allen, Fish-Culturist
Smokemont, N. C. - C. L. Edmondson, Fish-Culturist

Mississippi River and Great Lakes Territory: Headquarters: La Crosse, Wisc.
C. F. Fuller, District Supervisor

Duluth, Minn. - Ward A. Cook, Supt.
Fairport, Iowa - Leslie H. Bennett, Foreman
Farlington, Kansas - L. Glen Morse, Foreman
Hebron, Ohio - Geo M. Eisenlohr, Foreman
La Grosse, Wisc. - H. L. Canfield, Supt.
Genoa, Wisc. - Blaine Gillette, Apprentice Fish-Culturist
Guttenberg, Iowa - Eldon C. Saougling, Fish-Culturist
Homer, Minn. - John W. Gardner, Foreman
Lake Mills, Wisc. - Harry A. Carson, Foreman
Mammoth Spring, Ark. - Dell Brown, Supt.
Manchester, Iowa - G. H. Gill, Supt.
Neosho, Mo. - W. H. Thomas, Supt.

Mississippi River and Great Lakes Territory (Cont.)

Bourbon, Mo. - Byron Anderson, Fish-Culturist
Forest Park, St. Louis, Mo. - Geo. A. Tomeraasen, Foreman
Natchitoches, La. - Harry C. Minch, Foreman
Tishomingo, Okla. - Thad Kirby, Foreman
New London, Minn. - Hubert C. Topel, Foreman
Northville, Mich. - E. R. Widmyer, Supt.
Charlevoix, Mich. - Elisha M. Geer, Fish-Culturist
Put-in-Bay, Ohio - G. L. Heuchele, Supt.
Rochester, Indiana - C. H. Walker, Foreman
Valley City, North Dakota - C. E. Cozort, Foreman

Pacific Coast and Rocky Mountain Territory. Headquarters: 2725 Montlake Blvd. Seattle, Washington

Fred J. Foster, Regional Director
Alphonse Kemmerich, Superintendent at Large
Hanford Thayer, Superintendent of Construction
William Hagen, Jr., Junior Aquatic Biologist

Birdsview,(P.O. Concrete, Wash.) - Joseph Kemmerich, Supt.
Spokane, Wash., Rt. 7, Glen Tana Rd., - Adrien F. Bernier, Apprentice Fish-Culturist
Bozeman, Montana - Charles L. Fuqua, Supt.
Ennis, Montana - Ferd W. Hollingsworth, Foreman
Miles City, Montana - A. M. Lyall, Fish-Culturist
Carson, Washington - M. S. Meyer, Supt.
Little White Salmon (P.O. Cook, Wash.) - Lewis E. Harr, Fish-Culturist
Big White Salmon (P.O. Underwood, Wash.) - Alfred A. Genty, Foreman
Clackamas, Oregon - P. B. Hawley, Supt.
Battle Creek (P.O. Anderson, Calif.) - Chas. B. Wrangham, Fish-Culturist
Mill Creek (P.O. Los Molinos, Calif.) - Thad M. Blake, Fish-Culturist
Butte Falls, Oregon - Hasell Whiteman, Foreman

Clark Fork, Idaho - Walter C. Buckmaster, Foreman
Crawford, Nebraska - F. W. A. Englehardt, Foreman
Glacier National Park (P.O. Creston, Montana) - T. S. Kibbe, Supt.
Dexter, New Mexico - L. Q. Carman, Supt.
Santa Rosa, New Mexico - Nathan Fruchter, Fish-Culturist
Elephant Butte, New Mexico - Thos. F. Nelson, Foreman
Hagerman, Idaho - J. R. Russell, Supt.
Salmon, Idaho - Harold G. Kronholm, Apprentice Fish-Culturist
Las Vegas, Nevada - Ralph H. Olson, Fish-Culturist
Leadville, Colorado - G. W. Hoofnagle, Supt.
Creede, Colorado - John A. Thompson, Fish-Culturist
Mullan, Idaho - Donald C. Pryor, Fish-Culturist
Quinault, Wash. - A. T. Looff, Supt.
Quilcene, Wash. - John Pelnar, Foreman
Duckabush (P.O. Star Route, North Lilliwaup, Wash.) - Einar H.Evenson, Apprentice Fish-Culturist

Saratoga, Wyoming - Lloyd T. Pullum, Acting Supt.
Spearfish, South Dakota - J. F. Harrington, Foreman
Springville, Utah - C. D. Ryan, Supt.
Bear Lake (P.O. Laketown, Utah) - John S. Hill, Fish-Culturist.
Yellowstone Park, Wyoming - Address Seattle Office
Jackson, Wyoming - Harold B. Mailman, Fish-Culturist

FISH CAR DISTRIBUTION SERVICE

Edward J. Douglass, Supt. of Fish Distribution, Washington, D. C.
Thomas H. Copeland, Assistant Superintendent of Fish Distribution, La Crosse, Wisc.

Fish Distribution Car. No. 8
Headquarters: Washington, D. C.
Covers Western territory - A. A. Paul, Car Captain

Fish Distribution Car. No. 9
Headquarters: Washington, D. C.
Covers Eastern territory - V. W. Crandell, Car Captain

Fish Distribution Car. No. 10
Covers Central and Mississippi River territory - F. A. Copper, Car Captain

ALASKA DIVISION

Functions--Enforcement of laws and regulations for the protection of Alaska fisheries, fur seals, sea otters, walruses and sea lions; improvement of salmon spawning areas; assembling and disseminating fishery and fur-seal data; conducting of fur-sealing and foxing operations at the Pribilof Islands, and operation of a by-products plant for utilization of fur-seal carcasses; provision of food, fuel, clothing, housing, medical attention, schooling, and other necessities of life for native inhabitants and Bureau employees at the Pribilof Islands; purchase of equipment and supplies required in the maintenance of Alaska patrol vessels and in the prosecution of the Pribilof Islands fur-seal industry.

The staff of the Alaska Division consists of 31 permanent and approximately 130 temporary employees.

Fisheries Service

Seattle, Washington, 706 Federal Building
J. Steele Culbertson, Assistant Agent, (Acting Agent in Charge)
Bess E. O'Neil, Principal Clerk (In Juneau from June to Sept.)
Ted Murphy, Senior Clerk

Fairbanks, Alaska
*Calvin F. Townsend, Inspector

Yakutat, Alaska
*William B. Berry, Warden

*(At Seattle office in winter)

Fisheries Service (Cont.)

False Pass, Alaska
*Mark A. Logan, Warden

Kodiak , Alaska
*Ralph A. Ferrandini, Warden

Cordova, Alaska
*Clarence L. Olson, Warden

Chignik, Alaska
*Charles Petry, Warden

Wrangell, Alaska
*Alexander P. Romine, Warden

*(At Seattle office in winter)

Fur-Seal Service

Seattle, Washington
Thomas H. Erickson, Junior Administrative Assistant

St. George Island, via Dutch Harbor, Alaska
John W. Lipke, Agent and Caretaker
Eugene Mankovich, Physician
Purl L. Manderville, Storekeeper
John B. Schetzle, School Teacher
Lorin S. Schetzle, School Teacher

St. Paul Island, via Dutch Harbor, Alaska
Lee C. McMillin, Agent and caretaker
Anthony D. Migliore, Physician
Daniel C. R. Benson, Storekeeper
George R. Chute, Assistant to Agent
Elvin B. Elliott, Engineer and Radio Operator
Carl M. Hoverson, School Teacher
Geneva L. Hoverson, School Teacher

St. Louis, Missouri, 1328 South Kingshighway, c/o Fouke Fur Company
Flossie White, Senior Administrative Assistant

Masters of Vessels - Address c/o Seattle office, 706 Federal Building, in winter months
PENGUIN - Harold P. Knutsen, Unalaska, Alaska
BRANT - James R. Crawford, Juneau, Alaska
CRANE - Lin Jorgenson, False Pass, Alaska
TEAL - Roy L. Cole, Anchorage, Alaska
KITTIWAKE - Leo J. Collins, Ketchikan, Alaska
EIDER - George Skarbo, Kodiak, Alaska

Masters of Vessels (Cont.)

BLUE WING - (Vacancy), Cordova, Alaska
SCOTER - Ole H. Elveness, Naknek, Alaska
MURRE - Alvin T. Pickett, Craig, Alaska
AUKLET - Daniel Drotning, Wrangell, Alaska
WIDGEON - Albert N. Van Slyke, Juneau, Alaska

PELICAN - Edgar L. Raymond, Gulfport, Mississippi.